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GTP: A Microcomputer Program for the Spatial Equilibrium Problem

Forrest D. Holland

United States
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ABSTRACT

Competitive, spatial price equilibrium models have been used extensively by international agricultural trade economists as research and policy analysis tools. These mathematical models of international trade are solved on large mainframe computers. It has become feasible to solve small spatial price equilibrium models with microcomputers. This report describes a microcomputer program designed to solve small, single commodity spatial equilibrium models. The program, GTP (Generalized Transportation Problem), was developed on an IBM PC-XT personal computer, but it should run on most microcomputers based on the 8086 and 8088 microprocessors.

Keywords: Trade, spatial equilibrium, algorithm, computer program.

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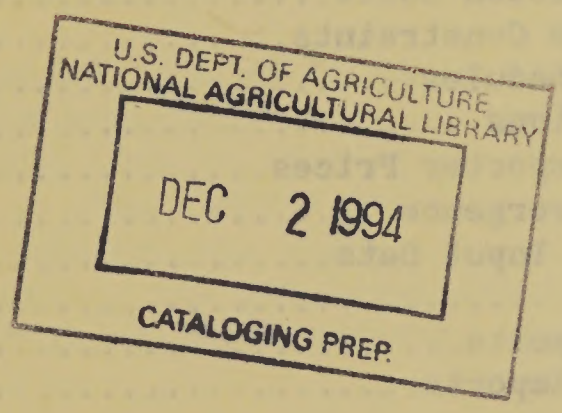

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SUMMARY

This report describes a computer program designed to solve small, single commodity, competitive, spatial price equilibrium models on an IBM personal computer. The computer program, GTP (Generalized Transportation Problem), allows up to 10 exporting regions and 25 importing regions. The user may specify lower and upper bound constraints on export and import quantities and on individual trade flows between exporting and importing regions. Specific and ad valorem tariffs and exchange rates are also allowed. Transportation costs between exporting and importing regions must be fixed per unit costs. Program GTP enforces a fixed functional form for excess supply and demand schedules. This functional form permits scalar, linear, constant elasticity, and a mixed type schedule for the excess functions.

Data for a particular spatial equilibrium problem is entered to the program interactively, and in the case of a previously defined problem, may be loaded into the program from a data file. Once an input data file is read into the program, the problem defined by the data file may be modified and resolved. Multiple versions of the input data for the same basic problem may be generated and saved on disk files. The program allows the user to write simple reports to the computer screen or to write more detailed reports to a file which may be routed to a printer.

A world wheat trade model containing 6 exporting regions and 16 importing regions is setup and solved to illustrate the use of GTP.

GTP: A Microcomputer Program for the Spatial Equilibrium Problem

Forrest D. Holland

INTRODUCTION

The report contains five parts. The first section presents the competitive, spatial price equilibrium model in terms of equilibrium conditions and constraints, lists the assumptions of the model, and presents the spatial equilibrium model in mathematical terms. The second section gives a brief history of the solution algorithm and a short, simplified description of the solution procedure. The third section focuses on the GTP (Generalized Transportation Problem) program commands, command functions, command syntax, and input and output data files. The fourth section deals with computer hardware requirements, specifically minimum memory and the desirability of an 8087 mathematical coprocessor. The final section presents a detailed example using an actual model of international wheat trade. This section presents the step-by-step process used to input model data, solve a model, and generate hardcopy reports with program GTP.

THE SPATIAL PRICE EQUILIBRIUM MODEL

The competitive, spatial price equilibrium model is used to describe the pricing and allocation of a commodity between exporting and importing regions separated by transportation costs. The assumptions of this model are (a) the markets behave competitively, (b) each region represents a distinct market place, (c) the commodity traded is homogeneous, (d) the quantities supplied and demanded are well-behaved functions of price, (e) the transportation costs are constant per unit costs, and (f) the exporting and importing regions may be specified a priori.

Spatial equilibrium models are usually static models. The competitive spatial price equilibrium model provides solution values given alternative policies or shocks, but does not provide information pertaining to the adjustment process embodied in the transition from one solution to another. An analyst typically builds a base period model, then asks "what if" type questions by varying model parameters and re-solving for the equilibrium.

Mathematical Model

The competitive, spatial price equilibrium problem may be expressed mathematically as a surplus maximization problem or equivalently as a set of

equilibrium conditions. I chose to state the problem in terms of equilibrium conditions.

Find: P_i, P_j, S_i, D_j, and X_{ij}

Such that: $S_i = S_i(P_i) = X_{i1} + X_{i2} + \ldots + X_{im}$

$$D_j = D_j(P_j) = X_{1j} + X_{2j} + \ldots + X_{nj}$$

$$S_1 + S_2 + \ldots + S_n = D_1 + D_2 + \ldots + D_m$$

Subject to: $SL_i \leq S_i \leq SU_i$

$$DL_j \leq D_j \leq DU_j$$

$$XL_{ij} \leq X_{ij} \leq XU_{ij}$$

$$P_i > 0$$

$$P_j = \text{Minimum}_{(i)} [\, L_j(P_i: XL_{ij} < X_{ij} < XU_{ij}\,]$$

Where: i = 1,n indexes exporters (sources),

j = 1,m indexes importers (sinks),

P_i = price of the ith exporter,

P_j = price of the jth importer,

S_i = excess supply of the ith exporter,

D_j = excess demand of the jth importer,

$S_i(P_i)$ = excess supply schedule of the ith exporter,

$D_j(P_j)$ = excess demand schedule of the jth importer,

X_{ij} = trade flow from the ith exporter to the jth importer,

SL_i = lower bound constraint on the ith exporter,

SU_i = upper bound constraint on the ith exporter,

DL_j = lower bound constraint on the jth importer,

DU_j = upper bound constraint on the jth importer,

XL_{ij} = lower bound constraint on the ij^{th} trade flow,

XU_{ij} = upper bound constraint on the ij^{th} trade flow, and

$L_j(P_i)$ = a price linkage function relating importer prices to exporter prices through exchange rates, tariffs, and transportation costs.

Price Linkage Mechanism

The price relationship between exporters (sources) and importers (sinks) is expressed through a price linkage function. The price linkage function describes the "wedge" between exporter and importer prices. In its simplest form, the price linkage function states that if an exporter and an importer are trade partners and no binding trade flow constraint exists between them, then their prices must differ by exactly the cost of transportation. In the more general form, the price linkage function contains exchange rates, specific and ad valorem tariffs, and transportation costs. The price linkage between the ith exporter and the jth importer may be expressed:

$$L_j(P_i) = (((P_i * (V_i + 1) + U_i) * E_i + T_{ij}) * (V_j + 1) / E_j) + U_j$$

Where V_i = an ad valorem tariff imposed by the ith exporter,

U_i = a specific tariff (in domestic currency units) imposed by the ith exporter,

E_i = exchange rate (base relative to domestic currency) for the ith exporter,

T_{ij} = transportation cost (in base currency units) from the ith exporter to the jth importer,

V_j = an ad valorem tariff imposed by the jth importer,

U_j = a specific tariff (in domestic currency units) imposed by the jth importer, and

E_j = exchange rate (base relative to domestic currency) for the jth importer.

The solution algorithm in GTP links import prices to export prices by choosing the least cost supplier for each importing region. If a trade flow constraint is binding, then the next lowest priced exporter supplies the remainder of the import demand. Notice that the price linkage function is analogous to the first order conditions for the surplus maximization formulation of the problem.

Excess Schedules

The excess supply and demand schedules may be simple schedules which map from a commodity price to quantity supplied or demanded, or they may be composite schedules which contain beginning inventory, a production schedule, primary and secondary domestic use schedules, and an ending inventory schedule. The solution algorithm used in program GTP is capable of finding solutions to spatial price equilibrium problems with very complicated excess schedules which may be nonsmooth (the derivative of the excess schedule with respect to price is discontinuous) and may even be correspondences (the mapping from price to quantity is point to set rather than point to point).

In program GTP the excess supply and demand functions are restricted to a particular functional form. Restricted functional forms are used in the program to simplify use of the solution package and to simplify the computer program. The excess schedules are of the form:

$$\text{Quantity} = \text{Alpha} + \text{Beta} * (\text{Price})^{\text{Gamma}}$$

This functional form allows scalar (Beta=0 and/or Gamma=0, linear (Beta≠0, Gamma=1), constant elasticity (Alpha=0, Beta>0, Gamma≠0), and mixed schedules (Alpha≠0, Beta≠0, and Gamma≠0).

Constraints, Tariffs, and Exchange Rates

The market constraints SL_i, SU_i, DL_j, and DU_j and the trade flow constraints XL_{ij} and XU_{ij} may be used to modify the competitive model to reflect "real world" conditions. The market constraints may correspond to actual quotas or may be used to represent price band policies. The trade flow constraints may reflect bilateral trade agreements, selective embargoes, or other poltically induced trade barriers. The specific tariffs U_i and U_j are used to impose a per unit tax (or subsidy) on each unit of the commodity traded. Ad valorem tariffs, V_i and V_j, apply to the value of trade rather than the quantity of trade. Specific tariffs are expressed in units of domestic currency per commodity unit, and ad valorem tariffs are expressed as a percentage of the value of trade.

The exchange rate vectors, E_i and E_j, specify the relationship between the domestic currencies of markets in the model. One of the regions (markets) in the model is chosen as a base, and the currencies of the other regions are expressed in terms of the base currency through the exchange rate vectors.

Further Reading

The competitive, spatial price equilibrium model enjoys a lengthy history. Enke [1] and Samuelson [5] presented the basic model and suggested solution algorithms in the early 1950's. 1/ Takayama and Judge's [6] formulation of the problem in quadratic programming terms in the midsixties allowed researchers to model and solve "real world" spatial equilibrium problems. Takayama and Judge's book [7] on modeling over space and time is an excellent presentation of spatial and related equilibrium models.

Of course the spatial equilibrium model is not without faults. The assumptions are somewhat restrictive, and empirical models are generally unable to replicate observed trade flows. In a recent survey of agricultural trade models, Thompson [8] discusses the strengths and weaknesses of spatial equilibrium models and alternative models of international trade.

THE SOLUTION ALGORITHM

The solution algorithm employed by program GTP to find a competitive, spatial price equilibrium is called the Vector Sandwich Method (VSM). The VSM algorithm is one of a class of algorithms referred to by various authors as fixed point, equilibria, homotopy, or path-following algorithms. No particular term dominates, but all of the algorithms in the class are path-following in the sense that given an initial point they follow a path leading to an equilibrium point.

1/ Numbers in brackets refer to references listed in the References section.

Kuhn and MacKinnon [3] originally developed the VSM algorithm to solve general equilibrium problems. The algorithm was subsequently applied to the generalized transportation problem (competitive, spatial price equilibrium) by MacKinnon [4]. I have used the VSM algorithm to solve simultaneous nonsmooth, nonlinear equation systems in market simulation models and to solve competitive, spatial price equilibrium problems.

Solution Procedure

The VSM algorithm is a simplicial approximation algorithm. The solution space is divided into nice sets called simplices, and a sophisticated search procedure is used to generate a path leading to an equilibrium point. The algorithm moves from simplex to simplex following a set of labeling rules. On each simplex a piecewise linear approximation to the underlying equation system is formed. Since the simplices are associated with piecewise linear approximation to the underlying equilibrium, the algorithm also forms a piecewise linear approximation to the solution path as it follows a path leading from an initial solution guess to an equilibrium point.

To move from an initial point to an equilibrium point, the algorithm needs only price vectors and the quantity vectors associated with the price vectors. There is no objective function and there are no derivatives, or system of path-following differential equations to evaluate. This results in marked flexibility in excess equation formulation and makes the algorithm relatively easy to use, but it also makes the algorithm converge more slowly than algorithms which use derivative information and/or exploit the structure of a particular equilibrium problem.

The inner workings of the algorithm are much more mathematically complex than the above description implies. The VSM algorithm is a complementary pivot algorithm which involves pivoting on the simplex vertices and basis changes associated with labeling vectors and vertex weights. From an empirical viewpoint, the mathematical structure of the algorithm is not that important. What is important is that this algorithm and similar algorithms can be used to solve spatial price equilibrium problems.

Simplicial subdivision algorithms do have an interesting computational property. Given some mild assumptions concerning the division of the solution space into simplices and the relationship between the piecewise linear approximations on adjacent simplices, these algorithms cannot cycle. A finite (perhaps large) number of function evaluations is guaranteed. In other words, if your problem has an equilibrium point, this algorithm will find it. If your problem does not have an equilibrium point, my program will either give you a message indicating that the algorithm did not converge to an equilibrium or "lock-up" your computer.

Problem Size

The VSM algorithm is not appropriate for solving large spatial equilibrium problems. The dimension of the search problem for the VSM algorithm is related to the cube of the number of endogenous prices. For the problem considered here, the number of endogenous prices is one plus the number of exporters in the spatial equilibrium model. This is the reason that I have constrained program GTP to no more than 10 exporting regions. The relationship between computational cost and the number of importing regions appears to be linear; and therefore, is rather insignificant compared with the computational cost

associated with exporting regions. I set the program maximum of 25 importing regions somewhat arbitrarily. This is a reasonable maximum number of importing regions for most spatial equilibrium models which would be solved on a microcomputer.

Further Reading

Readers interested in simplicial subdivision algorithms and other path-following algorithms for solving economic equilibria and similar problems will find a very readable discussion of the current "state-of-the-art" in Zangwill and Garcia [9].

USING THE COMPUTER PROGRAM

The computer program has two versions, GTP-SLOW.EXE and GTP-8087.EXE. The differences between the two versions of the program are explained in the Computer Hardware Requirements section. The program may be executed by typing GTP-SLOW or GTP-8087 if the program file is on the "logged drive," otherwise a drive specifier must precede the file name; for example, B:GTP-SLOW.

When the program begins execution, it prints a header which writes the program purpose and my name and phone number. The program then prompts for an initial input data file name (IDF) and an initial output data file name (ODF). The purpose and use of these two data files are explained in the Command Function Syntax section. After the initial data file names are entered or defaulted (by entering a carriage return; hereafter, abbreviated <return>), the program prompt appears. The program prompt is a solid right arrow which looks something like the usual DOS (Disk Operating System) prompt. The program is then ready for your input.

Commands

The program has only five commands (table 1). Two commands, SEE and SET, require the user to specify a function (subcommand). The SEE command may be used with all 30 functions (table 2) and the SET command may be used with the first 24 functions (IDF through RPC). The commands and functions are three letter strings which may be entered in either upper or lower case or both. If you fail to enter a command or function or misspell one, the program writes a list of legal commands or functions to the screen. If you need a list of the commands, enter <return> at the program prompt, and a list will appear on the screen. A list of functions (subcommands) may be obtained by entering SEE <return> or SET <return>.

Table 1--Program Commands

Name	Definition	Name	Definition
SEE	See Current Value(s)	SET	Set New Value(s)
RUN	Run The Solver	RPT	Write Reports
END	End Program Execution		

Command names reflect their purpose. The SEE command displays the current value of the specified function on the screen. For instance, SEE NXS displays the current value for the number of exporters, while SEE TFL displays the values for all lower bound trade flow constraints. The SET command allows the user to change various parameters. SET displays the old (current) value of an item on the screen and prompts for a new (replacement) value. If no new value is input, then the old value is retained by default. The SEE and SET commands differ from the other commands in that a function (subcommand) must be specified to tell the program what is to be seen or set.

The RUN command calls an error checking routine which scans the problem data for errors and inconsistent constraints. If an error is found, program GTP flags it by writing a message to the screen and the program returns its prompt (the solid right arrow). If this occurs, the user should correct the problem and then invoke the RUN command again. The error checking routine also flags some conditions which may or may not be errors. In this case, the user is asked whether or not the problem should be passed to the solution algorithm. If the error checking routine fails to find fatal errors or potential errors, the solution algorithm is automatically invoked. The solution algorithm writes a simple report of its progress while solving the problem. This report is described in detail below, under the heading "Convergence Progress".

Hardcopy reports are indirectly generated with the RPT command. RPT prompts the user to determine which reports to generate (table 3) and writes the reports on a formatted ASCII file. The user specifies the file name for these reports with the SET ODF command-function string. The user must then route this file to the printer using the DOS PRINT command. The reports generated with the RPT command are in a 133 column format and use standard form-feed

Table 2--SEE and/or SET Functions 1/

Name	Definition	Name	Definition
IDF	Input Data File Name	ODF	Output Data File Name
NXS	Number of Exporters	NMS	Number of Importers
LXS	Exporter Names	LMS	Importer Names
QLX	Exporter Supply Lower Bounds	QLM	Importer Demand Lower Bounds
QUX	Exporter Supply Upper Bounds	QUM	Importer Demand Upper Bounds
VTX	Exporter Ad Valorem Tariffs	VTM	Importer Ad Valorem Tariffs
STX	Exporter Specific Tariffs	STM	Importer Specific Tariffs
ERX	Exporter Exchange Rates	ERM	Importer Exchange Rates
TFL	Trade Flow Lower Bounds	TFU	Trade Flow Upper Bounds
CTS	Cost of Transport Services	TLE	Run Title
QSX	Exporter Supply Schedules	QDM	Importer Demand Schedules
PGX	Exporter Initial Prices	RPC	Relative Price Convergence
PTX	Exporter Price Report	PTM	Importer Price Report
QTX	Exporter Quantity Report	QTM	Importer Quantity Report
TFX	Exporter Trade Flow Report	TFM	Importer Trade Flow Report

1/ The first 24 functions (IDF through RPC) may be used with both the SEE and SET commands. The last six functions (PTX through TFM) may be used only with the SEE command.

(ASCII 12) and line-feed (ASCII 10) control codes. If you use an 80 column printer, you will need to set your printer to condensed print mode before you route the ODF file via the DOS PRINT or COPY commands. The file produced by the RPT command is compatible with Epson and Okidata dot matrix printers.

The END command prompts for file handling information for the input data file (IDF) and output data file (ODF), then terminates the program.

Functions

Most of the functions in table 2 are arranged in matched pairs pertaining to exporters and importers, respectively. For example, NXS is the function associated with the number of exporters, and the corresponding importer function is NMS. Exceptions to this rule include IDF and ODF, the input and output file name functions; TFL and TFU, the two trade flow bound functions; CTS, the transport cost function; TLE, the run title function; PGX, the initial export prices function; and RPC, the relative price convergence function.

The file handling functions, IDF and ODF, are used to specify input and output file names and file disposition. The computer program is designed to read and/or write input data files the user created from the data input. For example, if you create a model of international rice trade, you may save the rice model data on a file and subsequently load the data file in a later computer run. Before discussing the IDF and ODF functions in detail, I think some definitions and caveats should be considered.

There are two distinct types of files as far as this computer program is concerned: old refers to an existing file containing data and new refers to a file that does not contain data. Old files may be opened and their contents read into computer memory, while new files may be opened and have computer memory written to them. Files may be opened as either new or old files. If an old file is opened as a new file, the original contents of the file are automatically destroyed. This means that if you tell my program to use an existing data file as if it were a new file, then the contents of the original data file are irrevocably destroyed. It is difficult to accidentally destroy an existing disk file, but I make no warranty. Files also must be closed and their disposition declared. Files may be closed with keep (which saves the disk file) or delete (which destroys the disk file). I strongly suggest that

Table 3--Reports Available With The RPT Command

Report Description
Quota Levels, Tariffs, and Exchange Rates
Flow Constraints and Transport Costs
Excess Supply and Demand Schedules
Exporter (Source) Flows and Values
Importer (Sink) Flows and Values
Exporter (Source) Revenue and Importer (Sink) Cost
Price Linkages
Internal Prices and Tariff Equivalents
Solution Status and Author

you never use an original file with my program or any other microcomputer program. Make at least two backup copies of any valuable files, and use one of the backup copies in place of the original file.

I named the input data file function IDF. Data from a specific spatial equilibrium problem may be written to or read from this file. When the program begins execution, it asks for an initial IDF name. If you have an existing input data file, you may give the program the file name (and if necessary the drive specifier). In the case of an old file, the program will ask if you wish to have the file read into memory. In the usual case this is what you will want the program to do. If you do not want the existing data file read into memory, the program will ask you for an alternative file name. If you refuse to give one, the program will prompt to assure that you really want to destroy an existing data file. (The existing file is destroyed because the program must open it as a new file to write data to the file in case you wish to save the problem data). In the case of a new input data file, the program opens the file. However, no data are written to it until IDF is reset using the SET IDF command-function string or until program execution is terminated with the END command.

Once an input data file is read into memory, you may rerun the problem or make modifications, and then solve the modified problem. Whenever the SET IDF command-function sequence is invoked, the program checks to see if the current input data file is an old data file. If the file is an old file, the program gives you an opportunity to save the file. If you have made modifications, the program also gives you a chance to write the modified data file to the disk using a different file name. If you have not read an input data file into memory, as would be the case if you were entering data for a new problem, the program gives you an opportunity to save the problem data on the disk. The user can change the current input data file at any time by using the SET IDF command-function string. This command-function sequence allows modified versions of old data files to be saved on disk and also allows different problem data files to be read into computer memory. The file handling procedures discussed in this paragraph apply to the initial IDF prompt at the beginning of program execution, to any use of the SET IDF command-function string, and to program termination invoked via the END command.

The output data file (ODF) is treated in similar manner. In this case, the initial file should be a new data file, since the program does not read this file and cannot skip to the end of information on an old output data file. If the file already exists, the user is asked whether or not it should be destroyed. If the ODF file does not exist, a new file is opened and data may be written to it using the RPT command. The RPT command may be used several times within a single execution of the program to write reports for several spatial equilibrium problems on one output data file, or the SET ODF command-function string may be used to save the current output file and specify a different file name for subsequent reports.

NOTE: The program does not allow DOS 2.0 paths in file names. If you wish you could use the DOS CD (Change Directory) command to specify a path before executing my program. The procedure would be something like this. Suppose you have a hard disk drive called C: and you keep your spatial equilibrium problem data files in a directory named C:\SPATIAL\PROBLEMS. To use an input data file in this directory you could enter CD C:\SPATIAL\PROBLEMS at the DOS prompt before you begin execution of my program and answer the initial input data file prompt with C:File-Name. I prefer to copy the data

files to the current drive (or subdirectory on a hard disk) and work with a copy of the file rather than the original. I think that working with copies of files is a judicious precaution.

Functions NXS and NMS are used to define the number of regions. For exporters, the maximum is 10, and for importers the maximum is 25. The program enforces these limits. If you need to solve a larger problem the computer program must be modified, recompiled, and relinked. Note that you will need more memory and a lot more patience if you try to solve large problems with this program.

LXS and LMS are the respective exporter and importer region names. The names are restricted to 20 characters, and if you enter a longer name it will be truncated to 20 characters. Region names may contain any printable ASCII character.

The QLX and QLM functions are used to specify export and import quantity lower bounds. Exporters and importers may be forced to export (import) a specified minimum quantity. These constraints may be imposed by the user, but their primary use is internal to program GTP. The computer program totals the lower bound flow constraints (see TFL below) and sets the QLX and QLM vectors to the larger of the constraint totals or the actual minimum quantities. This is necessary, because in some conditions the sum of lower bound constraints may act as an export or import quantity lower bound. After the solution algorithm is invoked, the program resets the QLX and QLM vectors to their original (your input) values.

Functions QUX and QUM are the familiar market quota constraints. The ith exporter may export no more than QUX_i, and the jth importer may import no more than QUM_j. In the case where quota constraint is binding, an exporter (importer) will export (import) at the appropriate trade price as defined through the price linkage function, but the internal market price will be lower (higher) than the trade price.

VTX and VTM are respectively exporter and importer ad valorem tariffs. The ad valorem tariffs must be entered to the program as decimals; for example, 0.1 for 10 percent. The program will allow large (greater than 1.0 or 100 percent) and negative ad valorem tariffs but will prompt for confirmation of such values before it allows the solution algorithm to begin.

Functions STX and STM specify per unit or specific tariffs for exporting and importing regions. The specific tariffs are per unit charges levied on all exports or imports and must be input to the computer program in domestic currency units. As with ad valorem tariffs, the program allows large and negative specific tariffs but will ask for verification before starting the solution procedure.

The exchange rate functions are named ERX and ERM. The exchange rates are defined as units of base currency per unit of domestic currency. For example, if $1US were equivalent to 200 Japanese yen, and the U.S. dollar were the base currency, then Japan's exchange rate would be 0.005 (1/200).

Trade flow lower and upper bounds are entered with the TFL and TFU functions. TFL_{ij} specifies a minimum trade flow between the ith exporter and the jth importer, and TFU is used to declare maximum trade flows between trade partners. For example, these constraints would be used to simulate the limits

in the 1983 bilateral trade agreement between the United States and the Soviet Union. If you enter trade flow constraints which are inconsistent with the quota constraints, the program "beeps" at you and refuses to try to solve the problem.

Function CTS is used to set per unit transport costs where CTS_{ij} is the cost in base currency of transporting a commodity unit from the ith exporter to the jth importer. Zero or negative transportation costs are permitted, but the program considers such transport costs to be potential errors and prompts for confirmation before invoking the solution algorithm.

TLE is used to set a 50 character run title. The title is used only on the hardcopy reports generated via the RPT command. The title function is included in the program as an aid designed to keep track of alternative solutions. I suggest that the TLE function be used before each call to the hardcopy report writers available through the RPT command. If you enter a title with more than 50 characters, the program will truncate the title. A title may contain any printable ASCII character.

The excess supply and demand schedules are declared with functions QSX and QDM. Function QSX may be used to see the current coefficient values or set new values for exporter excess supply schedules, and the analogous function for importers is QDM. Recall from the section on the mathematical model that the functional form is:

$$\text{Quantity} = \text{Alpha} + \text{Beta} * (\text{Price})^{\text{Gamma}}$$

which allows scalar, linear, constant elasticity, and mixed schedules. In the computer program coefficient Alpha is labeled "A", Beta is "B", and Gamma is "C."

Function PGX is used to set initial ("guess") estimates of the exporter (source) prices. The algorithm uses the exporter prices to derive importer prices so initial values for importer prices are not required. The solution procedure is not highly sensitive to initial price values, but the initial values should be within the magnitude of the solution prices. In fact, if the "optimal" prices are given to the algorithm as initial price values, the algorithm will not realize that the initial values are "optimal." So, don't worry about precise initial exporter price estimates.

Function RPC is used to set a relative price convergence criterion for the solution algorithm. The solution procedure also employs a relative quantity convergence criterion, but it is not controllable by the program user and is set internally to 0. Convergence test values are calculated across major iterations (subdivisions) of the solution algorithm. When either convergence criterion, price or quantity, is achieved the solution procedure terminates. The convergence criteria are applied to the worst case situation. The price convergence criterion is applied to the largest relative change in exporter or importer prices, and the quantity convergence criterion applies to the largest relative change across all export and import quantities. The convergence criteria are expressed in decimal form where the number of zeros is approximately the worst case number of digits of accuracy in the solution.

For example, 0.000001 corresponds to a minimum of five digits of accuracy. The default value of RPC is zero. The algorithm will proceed until either RPC or the internal relative quantity convergence value (0) is less than or equal

to approximately $1.5 * 10^{-8}$. This corresponds to more than seven digits of accuracy for the worst case relative price or quantity change between major iterations.

The remaining functions, PTX, PTM, QTX, QTM, TFX, AND TFM, write reports to the screen. These reports are different than those produced by the report command RPT. If you like, you can route them to the printer with the PrtSc command. These reports give a short synopsis of the solution and are intended to provide a quick output. The reports generated by RPT are more comprehensive and provide more adequate data for comparing alternative solutions. PTX and PTM generate reports of trade, border, and domestic prices, and quota tariff equivalents. I define a trade price as the price at which a commodity is traded, a border price as the trade price less any tariffs for exporters or plus any tariffs for importers, and a domestic price as the internal price of the commodity. In the presence of binding quotas, the border price and the domestic price will not be the same. Functions QTX and QTM provide on screen trade quantity and revenue or cost reports, and functions TFX and TFM produce trade flow quantity and status reports.

Command and Function Syntax

Program commands are entered at the prompt. Commands RUN, RPT, and END require no additional information. Commands SEE and SET require a function name and, perhaps, function information. If additional information is entered for RUN, RPT, or END, it is ignored since these commands prompt for further information, if necessary. The SEE and SET commands must be accompanied by a function; for example, use SET NXS to set the number of exporting regions.

Some functions may pertain to a large quantity of data. For example, there are 96 transportation costs (function CTS) in the example problem presented in this report. The user may wish to SEE or SET only a few of these values. To do this, the user may provide optional indexing information. The syntax of the 24 SEE/SET functions is respectively for scalar, vector, and array functions:

```
CMD FTN
CMD FTN [,][first-index] [,last-index]
CMD FTN [,][first-index] [,last-index] [,first-index] [,last-index]
```

Where: CMD represents SEE or SET,
FTN represents one of the first 24 program functions (IDF through RPC), and
[ ] represents an optional integer index.

If the optional indices are not included, the program assumes that you wish to work with the entire vector or array. If only one indice is given for an index pair (first-index, last-index) then the program assumes that the item indexed is the only item with which you wish to work. If you indicate an index range, then the program assumes that you wish to work with the inclusive elements. The command syntax for the screen report writers (PTX through TFM) is the same as that of the scalar functions. The command syntax may be clarified with some examples:

```
(a) SEE LXS              (e) SEE CTS
(b) SEE LXS 1            (f) SEE CTS 1
(c) SEE LXS 1,5          (g) SEE CTS 2,4,3,6
(d) SEE LXS 3,5          (h) SEE CTS,,,5,6
```

Examples (a) through (d) illustrate the use of indices with vector functions. Example (a) defaults to all possible values of the exporter subscript, 1 through NXS. Example (b) requests the information for the first exporter only. Examples (c) and (d) indicate that the information be provided for a range of exporters; (c) for the first five exporters, and (d) for the third, fourth, and fifth exporters.

Examples (e) through (h) apply to array functions. Example (e) is similar to (a) in that all requested elements of the function are requested. In the case of arrays, the exporter indices are processed before the importer indices. Example (e) would display the transportation costs from the first exporter to each importer, then from the second exporter to each importer, and so forth. Example (f) would display the transportation costs from the first exporter to all importers. With example (g), the display would be restricted to the second, third, and fourth exporters and the third through sixth importers. The final example (h) illustrates the syntax used to display the transportation costs for all exporters and a selected range of importers. Either blanks or commas may be used as delimiters. Multiple blanks are ignored by the program, but the program assumes default values in the case of multiple commas (as in example (h) above).

Data Entry

Data entry is performed using the SET command. SET FTN (where FTN is one of the first 24 functions, IDF through RPC) displays the current value of a function or function element(s) and allows the user to enter a new value. The file handling functions IDF and ODF are exceptions to the general case since they prompt for additional user input. The scalar functions (NXS, NMS, RPC, and TLE) display the current data on one line and prompt for new data on the next line. All other functions display data and prompt for new data on the same line. The data entry prompt is best explained by example:

```
> SET VTX

ID    Region Name            Old VTX              New VTX  !
-------------------------------------------------------------
01    United States          .000                 -
```

In this example, SET VTX was entered at the program prompt, and the program responded by showing the current ad valorem tariff for the first region which is named "United States." The underscore represents the curser position. At this point the user may enter a new value for the tariff followed by a <return> or enter only a <return>. If a new value is entered, it is restricted to 10 digits (a decimal point is counted as a digit). The default value of 0 is retained if the user enters only a <return>. All vector and array data entry prompts contain the exclamation point (!) to indicate the end of the input data field. In all cases the current value is retained as the default value.

Convergence Progress

At the end of each major iteration of the solution algorithm, a cryptic message is written to the screen. The message contains the subdivision or major itera- tion count (subdivision), the current relative convergence test value for price convergence (RPC), the corresponding value for quantity convergence (RQC), the number of function evaluations for the excess supply schedules (CX) and excess demand schedules (CM), and the number of artificial labelings or "free pivots" (AL). An example of the convergence progress report is reproduced as table 4. This information may be used to follow the convergence progress and to indicate that the program is in fact running (see the comments pertaining to the 8087 coprocessor and execution time in the last section of the report).

When the solution algorithm terminates, it writes a message concerning the solution status. There are six possible messages:

(1). Requested Convergence Attained (RPC),
(2). Requested Convergence Attained (RQC),
(3). Requested Convergence Attained (RPC and RQC),
(4). Requested Convergence Could Not Be Attained,
(5). Excessive Basis Change Column Ties, and
(6). Basis Change Column Tie-Breaking Rule Failed.

The first three messages are self-explanatory. The fourth message is the normal termination message for the case where RPC = RQC = 0, since the algorithm will terminate automatically at a relative convergence of about $1.5 * 10^{-8}$. The final two messages, (5) and (6), indicate abnormal termination. Message (5) indicates that your problem is highly degenerate. The most likely cause for this message is that the transportation rates are zero or that several exporters are able to supply several importers at the least cost price (the price linkage function tends to "breakdown" with zero transportation costs or with models that contain many nonprice responsive

Table 4--An Example of Convergence Progress

Starting VSM Algorithm						
Subdivision: 1	RPC =1.13947167	RQC = .37767758	CX = 22	CM = 22	AL = 4	
Subdivision: 2	RPC = .35599548	RQC = .35177936	CX = 72	CM = 72	AL = 30	
Subdivision: 3	RPC = .02421318	RQC = .02684104	CX = 84	CM = 84	AL = 35	
Subdivision: 4	RPC = .00959192	RQC = .00843629	CX = 105	CM = 105	AL = 48	
Subdivision: 5	RPC = .00241675	RQC = .00157872	CX = 123	CM = 123	AL = 67	
Subdivision: 6	RPC = .00061272	RQC = .00032975	CX = 141	CM = 141	AL = 82	
Subdivision: 7	RPC = .00015787	RQC = .00007731	CX = 168	CM = 168	AL = 104	
Subdivision: 8	RPC = .00003514	RQC = .00001785	CX = 184	CM = 184	AL = 121	
Subdivision: 9	RPC = .00002082	RQC = .00001257	CX = 238	CM = 238	AL = 167	
Subdivision: 10	RPC = .00000205	RQC = .00000137	CX = 261	CM = 261	AL = 188	
Subdivision: 11	RPC = .00000042	RQC = .00000042	CX = 283	CM = 283	AL = 204	
Subdivision: 12	RPC = .00000030	RQC = .00000020	CX = 336	CM = 336	AL = 242	
Subdivision: 13	RPC = .00000003	RQC = .00000002	CX = 359	CM = 359	AL = 265	
Subdivision: 14	RPC = .00000001	RQC = .00000001	CX = 386	CM = 386	AL = 286	
Exit VSM:	RPC = .00000001	RQC = .00000001	CX = 387	CM = 387	AL = 286	
Requested Convergence Could Not Be Attained						

regions). The sixth convergence message should never appear. If it does, the user should check the excess schedules very closely for feasibility. Note that this algorithm will not solve the standard transportation problem. There is no "super source" or "super sink." At least some exporters and importers must be price responsive.

Scaling

The computer program tries to avoid numerical difficulties arising from poor scaling, but the user still needs to be aware that poor scaling may lead to ill-conditioned problems and bizarre error messages or nonsensical solution values. When choosing units, try to keep the product of price times quantity within a reasonable range, say below 10^7. Also, if at all possible, the price-quantity products should be of similar magnitude for all regions in the model. For agricultural commodities, I have found that prices expressed in $US per ton and quantity expressed in million metric tons or thousand metric tons are reasonable choices. I do not recommend building a corn model with prices expressed in cents per ton and quantity expressed in kilograms.

COMPUTER HARDWARE REQUIREMENTS

The computer program is relatively large in terms of both memory and computational requirements. For the best IBM personal computer performance, at least 192K of RAM and an 8087 mathematical coprocessor are required. The program will run without an 8087 coprocessor, but you will need a 256K machine and your patience may wear rather thin while you wait for the solution algorithm to converge.

The program is written in Fortran 77 (the solution algorithm and the hardcopy report writers were downloaded from a large mainframe), and I used Microsoft Fortran Version 3.2 to compile and link it. The Microsoft compiler package contains some alternative floating point mathematical libraries to be used in different computing environments. One of the mathematical libraries is specifically designed for the 8087 coprocessor.

To illustrate the importance of the 8087 coprocessor, I ran the same problem with versions of the program linked with alternative mathematical libraries. The program size and solution times for the alternative libraries are shown in table 5. This problem has 6 exporting regions, 16 importing regions, and 15 binding trade flow constraints. Two of the exporting regions have scalar excess supply schedules, and the other four have constant elasticity schedules. The excess demand schedules are evenly split between scalar and constant elasticity form, eight of each. For each of the three runs, I used

Table 5--Sample Problem Solution Times Using Alternative Mathematical Libraries

Library	Code Size (Bytes)	Time (Minutes:Seconds)
8087.LIB	156916	4:00
ALTMATH.LIB	168764	15:30
MATH.LIB	166084	32:45

the same initial guesses for the exporter prices and set RPC = 0. The solution accuracy for each run was about eight digits.

The 8087 mathematical library may be used only if the computer has an 8087 coprocessor. The other two libraries (MATH and ALTMATH) may be used whether or not the machine has an 8087 coprocessor. Programs linked with the ALTMATH library do faster floating point operations than programs linked with the MATH library on machines that do not have an 8087 coprocessor. However, programs linked with ALTMATH will not use an 8087 coprocessor even if it is available. Programs linked with the MATH library will use an 8087 coprocessor if one is available. However, programs linked with MATH execute very slowly on machines that do not have an 8087 coprocessor.

I have not had an opportunity to test the program on an 8086 based machine. An 8086 based machine without an 8087 coprocessor should give somewhat better solution times than an IBM personal computer without an 8087 coprocessor.

EXAMPLE PROBLEM

This section illustrates the step-by-step procedure to build and solve an actual spatial equilibrium model. I have chosen to use a 6 exporter and 16 importer model of world wheat trade for the example. This is the same model which was used as an example in comparing solution time in the preceding section. The model is similar to the model described in Holland and Sharples [2]. The only difference between the example model and the Holland-Sharples model is that the example model uses simple excess supply schedules while the Holland-Sharples model uses composite excess schedules with separate production, consumption, and stocks schedules.

The model in [2] was solved with a mainframe version of the GTP program which allows much more flexibility in excess schedule functional forms than the microcomputer version. The microcomputer version could be "tricked" into solving the model in [2] by specifying additional import regions which would correspond to the domestic use and stocks schedules of the composite excess schedules used in Holland-Sharples.

The assumptions embedded in the model and the data sources used for base period prices, quantities, and transportation costs may be found in the aforementioned reference. For the example, I assume that the user has formulated a model, has all necessary input data at hand, and is ready to solve the model with the computer.

Notation

In the following pages, material that the computer program generated on the screen is printed "**boldface**," and data the user entered is printed "normal." A carriage return (or enter) is denoted with the symbol <return>. The program prompt is printed as >. The program prompt is actually a solid right arrow, one of the nonprintable ASCII characters.

Getting Started

For day-to-day use, I renamed the 8087 version of the program GTP.EXE, and I usually operate from a RAM disk named B:. To run the program, I copy GTP.EXE

and the input data files I need from the hard disk to the RAM disk and enter GTP <return> at the B> prompt.

B> GTP <return>

This procedure will vary slightly if you have a different hardware configuration. In any case, program execution is initiated by typing the program name and a <return>.

The program responds by writing the following header, then prompts for initial names for the input data and output data files (IDF and ODF).

****

Solution of the Generalized Transportation
Problem Using the Vector Sandwich Method
Fixed-Point Algorithm of Kuhn and MacKinnon.

Address Questions and Comments To:

Forrest D. Holland, USDA-ERS-IED
Department of Agricultural Economics
Purdue University
West Lafayette, Indiana 47907

Phone: (317)-494-4311
(FTS)-284-4311

Coded on an IBM-XT using Microsoft Fortran

Version 1.0 - October 1984

****

Initial Input Data File Name (IDF)? WWM80S.IDF <return>

Initial Output Data File Name (ODF)? WWM80S.ODF <return>

In this example, we are entering data for a new problem. Therefore, I answered the IDF file name prompt with a name (WWM80S.IDF) which was not the same as an existing file on the logged drive. I could have included a drive designator in the file name. If a drive designator is not present in the file name, the program assumes that you wish to use the logged drive. I also entered a file name (WWM80S.ODF) for the initial output data file. Entering a <return> without file names at these file name prompts tells the program to use the default file names SCRATCH.IDF and SCRATCH.ODF.

Title and Number of Regions

The problem title is used only on the reports written via the RPT command. In general, one should enter a unique title if hardcopy reports of alternative versions of the problem are to be generated. I find that alternative titles are very helpful in keeping track of solutions. The title may contain any printable ASCII character and the default title is a null string.

```
> SET TLE <return>

                                                    50!
Old TLE:
New TLE:  Holland-Sharples 1980 Base Short-Run Wheat Model <return>
```

The "50!" indicates the end of the 50-column field that the program allocates for the run title. The exclamation point is in column 50.

The sample problem has 6 exporting regions and 16 importing regions. This data should be entered before any region specific data, since the program uses the number of exporters and importers as default index ranges for all input and output vectors and arrays. Other problem data may be entered in any order. As can be seen in the output reproduced below, the default values are 10 exporting regions and 25 importing regions.

```
> SET NXS <return>

Old NXS: 10
New NXS: 6 <return>

> SET NMS <return>

Old NMS: 25
New NMS: 16 <return>
```

Region Labels

The program allows 20-column labels for all exporting and importing regions in the model. The region labels are used by the SEE and SET functions, in the reports the program writes to the screen, and in the hardcopy reports generated with the RPT command. I suggest that region labels be entered immediately after the number of exporters and importers are entered, since the program uses the labels with the SEE and SET functions. The region labels may contain any printable ASCII character. The exclamation point in column 20 indicates the end of the region label field.

```
> SET LXS <return>

ID          Old LXS                          New LXS          !
-------------------------------------------------------------------
01          NO NAME REGION LABEL             Canada <return>
02          NO NAME REGION LABEL             United States <return>
03          NO NAME REGION LABEL             Argentina <return>
04          NO NAME REGION LABEL             EEC-10 Export <return>
05          NO NAME REGION LABEL             O. W. Europe Export <return>
06          NO NAME REGION LABEL             Australia <return>

> SET LMS <return>

ID          Old LMS                          New LMS          !
-------------------------------------------------------------------
01          NO NAME REGION LABEL             Central America <return>
02          NO NAME REGION LABEL             Brazil <return>
03          NO NAME REGION LABEL             Other S. America <return>
04          NO NAME REGION LABEL             EEC-10 Import <return>
```

```
05          NO NAME REGION LABEL          O. W. Europe Import <return>
06          NO NAME REGION LABEL          O. W. Europe Import <return>
06          NO NAME REGION LABEL          Eastern Europe <return>
07          NO NAME REGION LABEL          Soviet Union <return>
08          NO NAME REGION LABEL          People Rep. China <return>
09          NO NAME REGION LABEL          Japan <return>
10          NO NAME REGION LABEL          East Asia <return>
11          NO NAME REGION LABEL          Southeast Asia <return>
12          NO NAME REGION LABEL          South Asia <return>
13          NO NAME REGION LABEL          West Asia <return>
14          NO NAME REGION LABEL          North Africa <return>
15          NO NAME REGION LABEL          Central Africa <return>
16          NO NAME REGION LABEL          South Africa <return>
```

Transportation Costs

Entering transportation costs is a straightforward though tedious process, since a per unit cost must be entered for each possible trade flow. The default value for transportation costs is zero. A 10-column data field is allowed for transportation costs and all other floating point data. The exclamation point is in the tenth column.

```
> SET CTS 1 <return>
```

ID	Exporter (Source)	ID	Importer (Sink)	Old CTS	New CTS !
01	Canada	01	Central America	.000	19.3 <return>
01	Canada	02	Brazil	.000	21 <return>
01	Canada	03	Other S. America	.000	23 <return>
01	Canada	04	EEC-10 Import	.000	13.2 <return>
01	Canada	05	O. W. Europe Import	.000	15.4 <return>
01	Canada	06	Eastern Europe	.000	16 <return>
01	Canada	07	Soviet Union	.000	16.3 <return>
01	Canada	08	People Rep. China	.000	28.2 <return>
01	Canada	09	Japan	.000	20.3 <return>
01	Canada	10	East Asia	.000	26.6 <return>
01	Canada	11	Southeast Asia	.000	38.8 <return>
01	Canada	12	South Asia	.000	37 <return>
01	Canada	13	West Asia	.000	23.5 <return>
01	Canada	14	North Africa	.000	26.5 <return>
01	Canada	15	Central Africa	.000	31.2 <return>
01	Canada	16	South Africa	.000	35.4 <return>

```
> SET CTS 2 <return>
```

ID	Exporter (Source)	ID	Importer (Sink)	Old CTS	New CTS !
02	United States	01	Central America	.000	13.8 <return>
02	United States	02	Brazil	.000	15 <return>
02	United States	03	Other S. America	.000	16.5 <return>
02	United States	04	EEC-10 Import	.000	12 <return>
02	United States	05	O. W. Europe Import	.000	15.6 <return>
02	United States	06	Eastern Europe	.000	20.2 <return>
02	United States	07	Soviet Union	.000	19.8 <return>
02	United States	08	People Rep. China	.000	26.4 <return>
02	United States	09	Japan	.000	16.6 <return>

02	United States	10	East Asia	.000	28.2 <return>
02	United States	11	Southeast Asia	.000	48.2 <return>
02	United States	12	South Asia	.000	44.2 <return>
02	United States	13	West Asia	.000	30.4 <return>
02	United States	14	North Africa	.000	30.1 <return>
02	United States	15	Central Africa	.000	40 <return>
02	United States	16	South Africa	.000	34.5 <return>

> SET CTS 3 <return>

ID	Exporter (Source)	ID	Importer (Sink)	Old CTS	New CTS !
03	Argentina	01	Central America	.000	25.1 <return>
03	Argentina	02	Brazil	.000	15 <return>
03	Argentina	03	Other S. America	.000	20.5 <return>
03	Argentina	04	EEC-10 Import	.000	25.3 <return>
03	Argentina	05	O. W. Europe Import	.000	25 <return>
03	Argentina	06	Eastern Europe	.000	25.6 <return>
03	Argentina	07	Soviet Union	.000	25.1 <return>
03	Argentina	08	People Rep. China	.000	35.2 <return>
03	Argentina	09	Japan	.000	26.1 <return>
03	Argentina	10	East Asia	.000	34 <return>
03	Argentina	11	Southeast Asia	.000	27.5 <return>
03	Argentina	12	South Asia	.000	26.8 <return>
03	Argentina	13	West Asia	.000	31.8 <return>
03	Argentina	14	North Africa	.000	27 <return>
03	Argentina	15	Central Africa	.000	28.5 <return>
03	Argentina	16	South Africa	.000	32.1 <return>

> SET CTS 4 <return>

ID	Exporter (Source)	ID	Importer (Sink)	Old CTS	New CTS !
04	EEC-10 Export	01	Central America	.000	20 <return>
04	EEC-10 Export	02	Brazil	.000	20 <return>
04	EEC-10 Export	03	Other S. America	.000	21.7 <return>
04	EEC-10 Export	04	EEC-10 Import	.000	100 <return>
04	EEC-10 Export	05	O. W. Europe Import	.000	12 <return>
04	EEC-10 Export	06	Eastern Europe	.000	12.3 <return>
04	EEC-10 Export	07	Soviet Union	.000	15 <return>
04	EEC-10 Export	08	People Rep. China	.000	30 <return>
04	EEC-10 Export	09	Japan	.000	26.8 <return>
04	EEC-10 Export	10	East Asia	.000	30 <return>
04	EEC-10 Export	11	Southeast Asia	.000	35.1 <return>
04	EEC-10 Export	12	South Asia	.000	39 <return>
04	EEC-10 Export	13	West Asia	.000	18.1 <return>
04	EEC-10 Export	14	North Africa	.000	14.6 <return>
04	EEC-10 Export	15	Central Africa	.000	31.6 <return>
04	EEC-10 Export	16	South Africa	.000	35 <return>

> SET CTS 5 6 <return>

ID	Exporter (Source)	ID	Importer (Sink)	Old CTS	New CTS !
05	O. W. Europe Export	01	Central America	.000	25 <return>
05	O. W. Europe Export	02	Brazil	.000	25 <return>

05	O. W. Europe Export	03	Other S. America	.000	25 <return>
05	O. W. Europe Export	04	EEC-10 Import	.000	12 <return>
05	O. W. Europe Export	05	O. W. Europe Import	.000	100 <return>
05	O. W. Europe Export	06	Eastern Europe	.000	12.5 <return>
05	O. W. Europe Export	07	Soviet Union	.000	15 <return>
05	O. W. Europe Export	08	People Rep. China	.000	35 <return>
05	O. W. Europe Export	09	Japan	.000	30 <return>
05	O. W. Europe Export	10	East Asia.	.000	35 <return>
05	O. W. Europe Export	11	Southeast Asia	.000	40 <return>
05	O. W. Europe Export	12	South Asia	.000	40 <return>
05	O. W. Europe Export	13	West Asia	.000	20 <return>
05	O. W. Europe Export	14	North Africa	.000	15 <return>
05	O. W. Europe Export	15	Central Africa	.000	30 <return>
05	O. W. Europe Export	16	South Africa	.000	35 <return>

ID	Exporter (Source)	ID	Importer (Sink)	Old CTS	New CTS !
06	Australia	01	Central America	.000	27.5 <return>
06	Australia	02	Brazil	.000	27.5 <return>
06	Australia	03	Other S. America	.000	25.8 <return>
06	Australia	04	EEC-10 Import	.000	33.2 <return>
06	Australia	05	O. W. Europe Import	.000	39.6 <return>
06	Australia	06	Eastern Europe	.000	28 <return>
06	Australia	07	Soviet Union	.000	19.7 <return>
06	Australia	08	People Rep. China	.000	23.2 <return>
06	Australia	09	Japan	.000	18.2 <return>
06	Australia	10	East Asia	.000	23.2 <return>
06	Australia	11	Southeast Asia	.000	21.2 <return>
06	Australia	12	South Asia	.000	28 <return>
06	Australia	13	West Asia	.000	35.3 <return>
06	Australia	14	North Africa	.000	32.3 <return>
06	Australia	15	Central Africa	.000	32.9 <return>
06	Australia	16	South Africa	.000	25.8 <return>

Trade Flow Constraints

Entering trade flow constraints is nearly as boring as entering transportation costs. The example problem does not have any upper bound trade flow constraints, and we use the program default value of 500,000 for all trade flow upper bounds. Also, the fifth exporting region in the example (O. W. Europe Export) does not have any lower bound trade flow constraints and we allow the program to insert the default value of zero for these constraint values.

> SET TFL 1 4 <return>

ID	Exporter (Source)	ID	Importer (Sink)	Old TFL	New TFL !
01	Canada	01	Central America	.000	300 <return>
01	Canada	02	Brazil	.000	500 <return>
01	Canada	03	Other S. America	.000	<return>
01	Canada	04	EEC-10 Import	.000	<return>
01	Canada	05	O. W. Europe Import	.000	<return>
01	Canada	06	Eastern Europe	.000	500 <return>
01	Canada	07	Soviet Union	.000	3200 <return>
01	Canada	08	People Rep. China	.000	2800 <return>
01	Canada	09	Japan	.000	1300 <return>

01	Canada	10	East Asia	.000	<return>
01	Canada	11	Southeast Asia	.000	<return>
01	Canada	12	South Asia	.000	<return>
01	Canada	13	West Asia	.000	150 <return>
01	Canada	14	North Africa	.000	300 <return>
01	Canada	15	Central Africa	.000	<return>
01	Canada	16	South Africa	.000	<return>

ID	Exporter (Source)	ID	Importer (Sink)	Old TFL	New TFL !
02	United States	01	Central America	.000	600 <return>
02	United States	02	Brazil	.000	<return>
02	United States	03	Other S. America	.000	<return>
02	United States	04	EEC-10 Import	.000	<return>
02	United States	05	O. W. Europe Import	.000	75 <return>
02	United States	06	Eastern Europe	.000	750 <return>
02	United States	07	Soviet Union	.000	3000 <return>
02	United States	08	People Rep. China	.000	5100 <return>
02	United States	09	Japan	.000	<return>
02	United States	10	East Asia	.000	575 <return>
02	United States	11	Southeast Asia	.000	<return>
02	United States	12	South Asia	.000	<return>
02	United States	13	West Asia	.000	<return>
02	United States	14	North Africa	.000	2000 <return>
02	United States	15	Central Africa	.000	<return>
02	United States	16	South Africa	.000	<return>

ID	Exporter (Source)	ID	Importer (Sink)	Old TFL	New TFL !
03	Argentina	01	Central America	.000	<return>
03	Argentina	02	Brazil	.000	<return>
03	Argentina	03	Other S. America	.000	<return>
03	Argentina	04	EEC-10 Import	.000	<return>
03	Argentina	05	O. W. Europe Import	.000	<return>
03	Argentina	06	Eastern Europe	.000	<return>
03	Argentina	07	Soviet Union	.000	3000 <return>
03	Argentina	08	People Rep. China	.000	200 <return>
03	Argentina	09	Japan	.000	<return>
03	Argentina	10	East Asia	.000	<return>
03	Argentina	11	Southeast Asia	.000	<return>
03	Argentina	12	South Asia	.000	<return>
03	Argentina	13	West Asia	.000	200 <return>
03	Argentina	14	North Africa	.000	<return>
03	Argentina	15	Central Africa	.000	<return>
03	Argentina	16	South Africa	.000	<return>

ID	Exporter (Source)	ID	Importer (Sink)	Old TFL	New TFL !
04	EEC-10 Export	01	Central America	.000	<return>
04	EEC-10 Export	02	Brazil	.000	<return>
04	EEC-10 Export	03	Other S. America	.000	<return>
04	EEC-10 Export	04	EEC-10 Import	.000	<return>
04	EEC-10 Export	05	O. W. Europe Import	.000	<return>
04	EEC-10 Export	06	Eastern Europe	.000	<return>
04	EEC-10 Export	07	Soviet Union	.000	<return>
04	EEC-10 Export	08	People Rep. China	.000	500 <return>

04	EEC-10 Export	09	Japan	.000	<return>
04	EEC-10 Export	10	East Asia	.000	<return>
04	EEC-10 Export	11	Southeast Asia	.000	<return>
04	EEC-10 Export	12	South Asia	.000	<return>
04	EEC-10 Export	13	West Asia	.000	<return>
04	EEC-10 Export	14	North Africa	.000	800 <return>
04	EEC-10 Export	15	Central Africa	.000	<return>
04	EEC-10 Export	16	South Africa	.000	<return>

> SET TFL 6 <return>

ID	Exporter (Source)	ID	Importer (Sink)	Old TFL	New TFL !
06	Australia	01	Central America	.000	<return>
06	Australia	02	Brazil	.000	<return>
06	Australia	03	Other S. America	.000	<return>
06	Australia	04	EEC-10 Import	.000	<return>
06	Australia	05	O. W. Europe Import	.000	<return>
06	Australia	06	Eastern Europe	.000	<return>
06	Australia	07	Soviet Union	.000	<return>
06	Australia	08	People Rep. China	.000	2000 <return>
06	Australia	09	Japan	.000	900 <return>
06	Australia	10	East Asia	.000	600 <return>
06	Australia	11	Southeast Asia	.000	<return>
06	Australia	12	South Asia	.000	<return>
06	Australia	13	West Asia	.000	400 <return>
06	Australia	14	North Africa	.000	1000 <return>
06	Australia	15	Central Africa	.000	<return>
06	Australia	16	South Africa	.000	<return>

Excess Schedules

Entering excess schedule data is also a straightforward procedure. Users need to keep in mind that excess schedules must be specified in fixed functional form. The functional form is flexible enough for most applications, since it allows scalar, linear, and constant elasticity schedules. Note that the excess schedules must be written in the quantity dependent form, and the default schedule is scalar with a quantity value of zero. Also, recall that "A" corresponds to Alpha, "B" to Beta, and "C" to Gamma.

> SET QSX <return>

ID	Region Name	Coef.	Old Value	New Value!
01	Canada	QSX A	.000	<return>
		QSX B	.000	1225 <return>
		QSX C	1.000	0.5 <return>

ID	Region Name	Coef.	Old Value	New Value!
02	United States	QSX A	.000	<return>
		QSX B	.000	875 <return>
		QSX C	1.000	.75 <return>

ID	Region Name	Coef.	Old Value	New Value!
03	Argentina	QSX A	.000	<return>
		QSX B	.000	2450 <return>
		QSX C	1.000	.1 <return>

ID	Region Name	Coef.	Old Value	New Value!
04	EEC-10 Export	QSX A	.000	12300 <return>
		QSX B	.000	<return>
		QSX C	1.000	<return>

ID	Region Name	Coef.	Old Value	New Value!
05	O. W. Europe Export	QSX A	.000	800 <return>
		QSX B	.000	<return>
		QSX C	1.000	<return>

ID	Region Name	Coef.	Old Value	New Value!
06	Australia	QSX A	.000	<return>
		QSX B	.000	3275 <return>
		QSX C	1.000	0.25 <return>

> SET QDM <return>

ID	Region Name	Coef.	Old Value	New Value!
01	Central America	QDM A	.000	<return>
		QDM B	.000	10000 <return>
		QDM C	1.000	-.2 <return>

ID	Region Name	Coef.	Old Value	New Value!
02	Brazil	QDM A	.000	<return>
		QDM B	.000	12500 <return>
		QDM C	1.000	-.2 <return>

ID	Region Name	Coef.	Old Value	New Value!
03	Other S. America	QDM A	.000	<return>
		QDM B	.000	31500 <return>
		QDM C	1.000	-.4 <return>

ID	Region Name	Coef.	Old Value	New Value!
04	EEC-10 Import	QDM A	.000	4500 <return>
		QDM B	.000	<return>
		QDM C	1.000	<return>

ID	Region Name	Coef.	Old Value	New Value!
05	O. W. Europe Import	QDM A	.000	2200 <return>
		QDM B	.000	<return>
		QDM C	1.000	<return>

ID	Region Name	Coef.	Old Value	New Value!
06	Eastern Europe	QDM A	.000	5300 <return>
		QDM B	.000	<return>
		QDM C	1.000	<return>

ID	Region Name	Coef.	Old Value	New Value!
07	Soviet Union	QDM A	.000	15100 <return>
		QDM B	.000	<return>
		QDM C	1.000	<return>

ID	Region Name	Coef.	Old Value	New Value!
08	People Rep. China	QDM A	.000	<return>
		QDM B	.000	825000 <return>
		QDM C	1.000	-.8 <return>

ID	Region Name	Coef.	Old Value	New Value!
09	Japan	QDM A	.000	5500 <return>
		QDM B	.000	<return>
		QDM C	1.000	<return>

ID	Region Name	Coef.	Old Value	New Value!
10	East Asia	QDM A	.000	<return>
		QDM B	.000	52500 <return>
		QDM C	1.000	-.4 <return>

ID	Region Name	Coef.	Old Value	New Value!
11	Southeast Asia	QDM A	.000	<return>
		QDM B	.000	55000 <return>
		QDM C	1.000	-.8 <return>

ID	Region Name	Coef.	Old Value	New Value!
12	South Asia	QDM A	.000	<return>
		QDM B	.000	250000 <return>
		QDM C	1.000	-.8 <return>

ID	Region Name	Coef.	Old Value	New Value!
13	West Asia	QDM A	.000	7000 <return>
		QDM B	.000	<return>
		QDM C	1.000	<return>

ID	Region Name	Coef.	Old Value	New Value!
14	North Africa	QDM A	.000	11000 <return>
		QDM B	.000	<return>
		QDM C	1.000	<return>

ID	Region Name	Coef.	Old Value	New Value!
15	Central Africa	QDM A	.000	<return>
		QDM B	.000	290000 <return>
		QDM C	1.000	-.8 <return>

ID	Region Name	Coef.	Old Value	New Value!
16	South Africa	QDM A	.000	100 <return>
		QDM B	.000	<return>
		QDM C	1.000	<return>

SET Functions

At this point in the data entry process, I decided that I needed to see all of the SET functions to insure that I had entered all of the data necessary for this spatial equilibrium problem. One way to get a list of the functions is illustrated below.

```
> SET <return>

Unrecognizable SET Function
```

FTN	Definition	FTN	Definition
IDF	Input Data File Name	ODF	Output Data File Name
NXS	Number of Exporters	NMS	Number of Importers
LXS	Exporter Names	LMS	Importer Names
QLX	Exporter Supply Lower Bounds	QLM	Importer Demand Lower Bounds
QUX	Exporter Supply Upper Bounds	QUM	Importer Demand Upper Bounds
VTX	Exporter Ad Valorem Tariffs	VTM	Importer Ad Valorem Tariffs
STX	Exporter Specific Tariffs	STM	Importer Specific Tariffs
ERX	Exporter Exchange Rates	ERM	Importer Exchange Rates
TFL	Trade Flow Lower Bounds	TFU	Trade Flow Upper Bounds
CTS	Cost of Transport Services	TLE	Run Title
QSX	Exporter Supply Schedules	QDM	Importer Demand Schedules
PGX	Exporter Initial Prices	RPC	Relative Price Convergence

In looking over the list, I discovered that I had forgotten to enter initial prices for the exporting regions.

Initial Exporter Prices

Initial estimates of the prices for the exporting regions must be entered, since the program will not attempt to solve a spatial equilibrium problem, unless you give it some indication of the expected price levels. The program uses default values of -1 to insure that positive initial price guesses have been entered. I knew that actual wheat export prices for the base period in the example problem had been around $200 per ton, so I used this value as an initial guess for all exporting regions (all prices are expressed in U.S. dollars and all exchange rates are one in this problem).

> SET PGX <return>

ID	Region Name	Old PGX	New PGX !
01	Canada	-1.000	200 <return>
02	United States	-1.000	200 <return>
03	Argentina	-1.000	200 <return>
04	EEC-10 Export	-1.000	200 <return>
05	O. W. Europe Export	-1.000	200 <return>
06	Australia	-1.000	200 <return>

Price Convergence

The user may set the relative price convergence criteria or use the program default value of zero. Recall that if the convergence criteria is zero then the program will run the solution algorithm until the worst case relative price or quantity change is about $1.5 * 10^{-8}$. I recommend that you use the default value unless you are certain that a looser tolerance is appropriate for your problem. To see the relative price convergence value:

> SEE RPC <return>

Current RPC: .00000000

Reviewing Input Data

The SEE command may be used at any time to review the data that you have entered or to see the program default values. In the examples below, I review the excess supply schedules and look at the default values that the program inserted for the exporter exchange rates, specific tariffs, and ad valorem tariffs. Since the program always uses the same default values for exporting and importing regions, I did not review the exchange rate and tariff data for the importing regions.

> SEE QSX <return>

ID	Region Name	Current QSX A	Current QSX B	Current QSX C
01	Canada	.000	1225.000	.500
02	United States	.000	875.000	.750
03	Argentina	.000	2450.000	.100
04	EEC-10 Export	12300.000	.000	1.000
05	O. W. Europe Export	800.000	.000	1.000
06	Australia	.000	3275.000	.250

```
> SEE ERX <return>
```

ID	Region Name	Current ERX
01	Canada	1.000
02	United States	1.000
03	Argentina	1.000
04	EEC-10 Export	1.000
05	O. W. Europe Export	1.000
06	Australia	1.000

```
> SEE STX <return>
```

ID	Region Name	Current STX
01	Canada	.000
02	United States	.000
03	Argentina	.000
04	EEC-10 Export	.000
05	O. W. Europe Export	.000
06	Australia	.000

```
> SEE VTX <return>
```

ID	Region Name	Current VTX
01	Canada	.000
02	United States	.000
03	Argentina	.000
04	EEC-10 Export	.000
05	O. W. Europe Export	.000
06	Australia	.000

Solving

The RUN command is invoked to solve a spatial equilibrium problem. The program first examines the input data for errors and potential errors. Errors are things like excess schedules with the wrong slope, inconsistent market quotas and trade flow constraints, and negative initial exporter prices. Potential errors are things like zero transportation costs and large or negative tariffs.

If errors are found, the program writes a message about them to the screen and refuses to try to solve the problem. If the program finds potential errors, it writes a message to the screen and asks whether or not to begin the solution algorithm. No errors or potential errors were found in the example problem.

```
> RUN <return>

Scanning For Data Errors...

Starting VSM Algorithm
Subdivision:  1  RPC = .51041205  RQC = .23892995  CX =   8  CM =   8  AL =   7
Subdivision:  2  RPC = .17821953  RQC = .17716688  CX =  51  CM =  51  AL =  27
Subdivision:  3  RPC = .03378388  RQC = .01687571  CX =  80  CM =  80  AL =  42
```

```
Subdivision:  4  RPC = .01319149  RQC = .00249387  CX = 116  CM = 116  AL =  65
Subdivision:  5  RPC = .00200538  RQC = .00101902  CX = 143  CM = 143  AL =  97
Subdivision:  6  RPC = .00067598  RQC = .00013833  CX = 189  CM = 189  AL = 125
Subdivision:  7  RPC = .00020301  RQC = .00007891  CX = 234  CM = 234  AL = 145
Subdivision:  8  RPC = .00005837  RQC = .00002221  CX = 278  CM = 278  AL = 181
Subdivision:  9  RPC = .00001791  RQC = .00000453  CX = 306  CM = 306  AL = 211
Subdivision: 10  RPC = .00000384  RQC = .00000046  CX = 356  CM = 356  AL = 258
Subdivision: 11  RPC = .00000103  RQC = .00000054  CX = 434  CM = 434  AL = 304
Subdivision: 12  RPC = .00000030  RQC = .00000005  CX = 506  CM = 506  AL = 339
Subdivision: 13  RPC = .00000005  RQC = .00000003  CX = 557  CM = 557  AL = 377
Subdivision: 14  RPC = .00000001  RQC = .00000000  CX = 595  CM = 595  AL = 415
Exit VSM:        RPC = .00000001  RQC = .00000000  CX = 596  CM = 596  AL = 415
Requested Convergence Could Not Be Attained
```

Screen Reports

The program can write six different reports to the screen. There are three report types: price and quota tariff equivalents; trade quantity, value, and revenue; and trade flow quantity and price linkage reports. Each of these reports is available for both exporters and importers.

The price and quota tariff equivalents report shows trade, border, and domestic prices by region. If binding quotas are present this report also displays the specific and ad valorem tariff equivalents.

```
> SEE PTX <return>
```

ID	Exporter (Source)	Prices			Quota Tariffs	
		Trade	Border	Domestic	Specific	A-Valorem
01	Canada	182.395	182.395	182.395	.000	.000
02	United States	178.195	178.195	178.195	.000	.000
03	Argentina	185.095	185.095	185.095	.000	.000
04	EEC-10 Export	187.795	187.795	187.795	.000	.000
05	O. W. Europe Export	187.395	187.395	187.395	.000	.000
06	Australia	183.195	183.195	183.195	.000	.000
	Weighted Average	181.400	181.400	181.400	.000	.000

```
> SEE PTM <return>
```

ID	Importer (Sink)	Prices			Quota Tariffs	
		Trade	Border	Domestic	Specific	A-Valorem
01	Central America	191.995	191.995	191.995	.000	.000
02	Brazil	193.195	193.195	193.195	.000	.000
03	Other S. America	194.695	194.695	194.695	.000	.000
04	EEC-10 Import	190.195	190.195	190.195	.000	.000
05	O. W. Europe Import	193.795	193.795	193.795	.000	.000
06	Eastern Europe	198.395	198.395	198.395	.000	.000
07	Soviet Union	197.995	197.995	197.995	.000	.000
08	People Rep. China	204.595	204.595	204.595	.000	.000
09	Japan	194.795	194.795	194.795	.000	.000
10	East Asia	206.395	206.395	206.395	.000	.000
11	Southeast Asia	204.395	204.395	204.395	.000	.000
12	South Asia	211.195	211.195	211.195	.000	.000
13	West Asia	205.895	205.895	205.895	.000	.000

14	North Africa	202.395	202.395	202.395	.000	.000
15	Central Africa	213.595	213.595	213.595	.000	.000
16	South Africa	208.995	208.995	208.995	.000	.000
	Weighted Average	200.621	200.621	200.621	.000	.000

The next set of screen reports gives the quantity traded, value of trade, specific and ad valorem tariff receipts, and the net revenue or cost by region and for the aggregate of all regions.

> SEE QTX <return>

		---- Quantity ---		----- Tariffs -----		Revenue
ID	Exporter (Source)	Traded	Value	Specific	A-Valorem	or Cost
01	Canada	16544.082	3017559.7	.0	.0	3017559.7
02	United States	42675.625	7604587.6	.0	.0	7604587.6
03	Argentina	4129.577	764364.5	.0	.0	764364.5
04	EEC-10 Export	12300.000	2309879.8	.0	.0	2309879.8
05	O. W. Europe Export	800.000	149916.1	.0	.0	149916.1
06	Australia	12048.688	2207260.8	.0	.0	2207260.8
	Global (Total)	88497.973	16053568.6	.0	.0	16053568.6

> SEE QTM <return>

		---- Quantity ---		----- Tariffs -----		Revenue
ID	Importer (Sink)	Traded	Value	Specific	A-Valorem	or Cost
01	Central America	3494.153	670860.4	.0	.0	670860.4
02	Brazil	4362.252	842765.8	.0	.0	842765.8
03	Other S. America	3824.446	744600.9	.0	.0	744600.9
04	EEC-10 Import	4500.000	855878.0	.0	.0	855878.0
05	O. W. Europe Import	2200.000	426349.2	.0	.0	426349.2
06	Eastern Europe	5300.000	1051494.1	.0	.0	1051494.1
07	Soviet Union	15100.000	2989726.2	.0	.0	2989726.2
08	People Rep. China	11687.934	2391294.1	.0	.0	2391294.1
09	Japan	5500.000	1071373.1	.0	.0	1071373.1
10	East Asia	6227.010	1285224.3	.0	.0	1285224.3
11	Southeast Asia	779.805	159388.4	.0	.0	159388.4
12	South Asia	3452.971	729250.6	.0	.0	729250.6
13	West Asia	7000.000	1441265.8	.0	.0	1441265.8
14	North Africa	11000.000	2226346.2	.0	.0	2226346.2
15	Central Africa	3969.401	847844.6	.0	.0	847844.6
16	South Africa	100.000	20899.5	.0	.0	20899.5
	Global (Total)	88497.973	17754561.2	.0	.0	17754561.2

The final set of screen reports shows the individual trade flows between regions, the value of the price linkage function, and the "state" of the trade flow. The price linkage function value may be interpreted as a shadow price. It is zero for "optimal" flows, negative for flows which are at the upper bound constraint, and positive for flows which are at the lower bound constraint. The "state" of the trade flow is OPT for an optimal (least cost) flow, LBC for a lower bound constrained flow, UBC for an upper bound constrained flow, and null for a nonoptimal, nonbinding flow.

> SEE TFX <return>

ID	Exporter (Source)	ID	Importer (Sink)	Quantity	Linkage	State
01	Canada	01	Central America	300.000	9.700	LBC
01	Canada	02	Brazil	500.000	10.200	LBC
01	Canada	03	Other S. America	.000	10.700	
01	Canada	04	EEC-10 Import	.000	5.400	
01	Canada	05	O. W. Europe Import	.000	4.000	
01	Canada	06	Eastern Europe	3404.259	.000	OPT
01	Canada	07	Soviet Union	3200.000	.700	LBC
01	Canada	08	People Rep. China	2800.000	6.000	LBC
01	Canada	09	Japan	1300.000	7.900	LBC
01	Canada	10	East Asia	.000	2.600	
01	Canada	11	Southeast Asia	.000	16.800	
01	Canada	12	South Asia	.000	8.200	
01	Canada	13	West Asia	1500.000	.000	OPT
01	Canada	14	North Africa	300.000	6.500	LBC
01	Canada	15	Central Africa	3239.824	.000	OPT
01	Canada	16	South Africa	.000	8.800	
01	Canada		Global (Total)	16544.082		

Please press <return> to continue. <return>

ID	Exporter (Source)	ID	Importer (Sink)	Quantity	Linkage	State
02	United States	01	Central America	3194.153	.000	OPT
02	United States	02	Brazil	3862.252	.000	OPT
02	United States	03	Other S. America	3824.446	.000	OPT
02	United States	04	EEC-10 Import	4500.000	.000	OPT
02	United States	05	O. W. Europe Import	2200.000	.000	OPT
02	United States	06	Eastern Europe	1895.741	.000	OPT
02	United States	07	Soviet Union	8900.000	.000	OPT
02	United States	08	People Rep. China	6187.934	.000	OPT
02	United States	09	Japan	3300.000	.000	OPT
02	United States	10	East Asia	2811.098	.000	OPT
02	United States	11	Southeast Asia	.000	22.000	
02	United States	12	South Asia	.000	11.200	
02	United States	13	West Asia	.000	2.700	
02	United States	14	North Africa	2000.000	5.900	LBC
02	United States	15	Central Africa	.000	4.600	
02	United States	16	South Africa	.000	3.700	
02	United States		Global (Total)	42675.625		

Please press <return> to continue. <return>

ID	Exporter (Source)	ID	Importer (Sink)	Quantity	Linkage	State
03	Argentina	01	Central America	.000	18.200	
03	Argentina	02	Brazil	.000	6.900	
03	Argentina	03	Other S. America	.000	10.900	
03	Argentina	04	EEC-10 Import	.000	20.200	
03	Argentina	05	O. W. Europe Import	.000	16.300	
03	Argentina	06	Eastern Europe	.000	12.300	
03	Argentina	07	Soviet Union	3000.000	12.200	LBC
03	Argentina	08	People Rep. China	200.000	15.700	LBC
03	Argentina	09	Japan	.000	16.400	
03	Argentina	10	East Asia	.000	12.700	

03	Argentina	11	Southeast Asia	.000	8.200	
03	Argentina	12	South Asia	.000	.700	
03	Argentina	13	West Asia	200.000	11.000	LBC
03	Argentina	14	North Africa	.000	9.700	
03	Argentina	15	Central Africa	729.577	.000	OPT
03	Argentina	16	South Africa	.000	8.200	
03	Argentina		Global (Total)	4129.577		

Please press <return> to continue. <return>

ID	Exporter (Source)	ID	Importer (Sink)	Quantity	Linkage	State
04	EEC-10 Export	01	Central America	.000	15.800	
04	EEC-10 Export	02	Brazil	.000	14.600	
04	EEC-10 Export	03	Other S. America	.000	14.800	
04	EEC-10 Export	04	EEC-10 Import	.000	97.600	
04	EEC-10 Export	05	O. W. Europe Import	.000	6.000	
04	EEC-10 Export	06	Eastern Europe	.000	1.700	
04	EEC-10 Export	07	Soviet Union	.000	4.800	
04	EEC-10 Export	08	People Rep. China	500.000	13.200	LBC
04	EEC-10 Export	09	Japan	.000	19.800	
04	EEC-10 Export	10	East Asia	.000	11.400	
04	EEC-10 Export	11	Southeast Asia	.000	18.500	
04	EEC-10 Export	12	South Asia	.000	15.600	
04	EEC-10 Export	13	West Asia	4900.000	.000	OPT
04	EEC-10 Export	14	North Africa	6900.000	.000	OPT
04	EEC-10 Export	15	Central Africa	.000	5.800	
04	EEC-10 Export	16	South Africa	.000	13.800	
04	EEC-10 Export		Global (Total)	12300.000		

Please press <return> to continue. <return>

ID	Exporter (Source)	ID	Importer (Sink)	Quantity	Linkage	State
05	O. W. Europe Export	01	Central America	.000	20.400	
05	O. W. Europe Export	02	Brazil	.000	19.200	
05	O. W. Europe Export	03	Other S. America	.000	17.700	
05	O. W. Europe Export	04	EEC-10 Import	.000	9.200	
05	O. W. Europe Export	05	O. W. Europe Import	.000	93.600	
05	O. W. Europe Export	06	Eastern Europe	.000	1.500	
05	O. W. Europe Export	07	Soviet Union	.000	4.400	
05	O. W. Europe Export	08	People Rep. China	.000	17.800	
05	O. W. Europe Export	09	Japan	.000	22.600	
05	O. W. Europe Export	10	East Asia	.000	16.000	
05	O. W. Europe Export	11	Southeast Asia	.000	23.000	
05	O. W. Europe Export	12	South Asia	.000	16.200	
05	O. W. Europe Export	13	West Asia	.000	1.500	
05	O. W. Europe Export	14	North Africa	800.000	.000	OPT
05	O. W. Europe Export	15	Central Africa	.000	3.800	
05	O. W. Europe Export	16	South Africa	.000	13.400	
05	O. W. Europe Export		Global (Total)	800.000		

Please press <return> to continue. <return>

ID	Exporter (Source)	ID	Importer (Sink)	Quantity	Linkage	State
06	Australia	01	Central America	.000	18.700	
06	Australia	02	Brazil	.000	17.500	
06	Australia	03	Other S. America	.000	14.300	
06	Australia	04	EEC-10 Import	.000	26.200	
06	Australia	05	O. W. Europe Import	.000	29.000	
06	Australia	06	Eastern Europe	.000	12.800	
06	Australia	07	Soviet Union	.000	4.900	
06	Australia	08	People Rep. China	2000.000	1.800	LBC
06	Australia	09	Japan	900.000	6.600	LBC
06	Australia	10	East Asia	3415.912	.000	OPT
06	Australia	11	Southeast Asia	779.805	.000	OPT
06	Australia	12	South Asia	3452.971	.000	OPT
06	Australia	13	West Asia	400.000	12.600	LBC
06	Australia	14	North Africa	1000.000	13.100	LBC
06	Australia	15	Central Africa	.000	2.500	
06	Australia	16	South Africa	100.000	.000	OPT
06	Australia		Global (Total)	12048.688		

Non-Zero Non-Binding Flows (OPT): 21
Binding Lower Bound Constraints (LBC): 15
Binding Upper Bound Constraints (UBC): 00

> SEE TFM <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
01	Central America	01	Canada	300.000	9.700	LBC
01	Central America	02	United States	3194.153	.000	OPT
01	Central America	03	Argentina	.000	18.200	
01	Central America	04	EEC-10 Export	.000	15.800	
01	Central America	05	O. W. Europe Export	.000	20.400	
01	Central America	06	Australia	.000	18.700	
01	Central America		Global (Total)	3494.153		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
02	Brazil	01	Canada	500.000	10.200	LBC
02	Brazil	02	United States	3862.252	.000	OPT
02	Brazil	03	Argentina	.000	6.900	
02	Brazil	04	EEC-10 Export	.000	14.600	
02	Brazil	05	O. W. Europe Export	.000	19.200	
02	Brazil	06	Australia	.000	17.500	
02	Brazil		Global (Total)	4362.252		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
03	Other S. America	01	Canada	.000	10.700	
03	Other S. America	02	United States	3824.446	.000	OPT

03	Other S. America	03	Argentina	.000	10.900	
03	Other S. America	04	EEC-10 Export	.000	14.800	
03	Other S. America	05	O. W. Europe Export	.000	17.700	
03	Other S. America	06	Australia	.000	14.300	
03	Other S. America		Global (Total)	3824.446		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
04	EEC-10 Import	01	Canada	.000	5.400	
04	EEC-10 Import	02	United States	4500.000	.000	OPT
04	EEC-10 Import	03	Argentina	.000	20.200	
04	EEC-10 Import	04	EEC-10 Export	.000	97.600	
04	EEC-10 Import	05	O. W. Europe Export	.000	9.200	
04	EEC-10 Import	06	Australia	.000	26.200	
04	EEC-10 Import		Global (Total)	4500.000		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
05	O. W. Europe Import	01	Canada	.000	4.000	
05	O. W. Europe Import	02	United States	2200.000	.000	OPT
05	O. W. Europe Import	03	Argentina	.000	16.300	
05	O. W. Europe Import	04	EEC-10 Export	.000	6.000	
05	O. W. Europe Import	05	O. W. Europe Export	.000	93.600	
05	O. W. Europe Import	06	Australia	.000	29.000	
05	O. W. Europe Import		Global (Total)	2200.000		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
06	Eastern Europe	01	Canada	3404.259	.000	OPT
06	Eastern Europe	02	United States	1895.741	.000	OPT
06	Eastern Europe	03	Argentina	.000	12.300	
06	Eastern Europe	04	EEC-10 Export	.000	1.700	
06	Eastern Europe	05	O. W. Europe Export	.000	1.500	
06	Eastern Europe	06	Australia	.000	12.800	
06	Eastern Europe		Global (Total)	5300.000		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
07	Soviet Union	01	Canada	3200.000	.700	LBC
07	Soviet Union	02	United States	8900.000	.000	OPT
07	Soviet Union	03	Argentina	3000.000	12.200	LBC
07	Soviet Union	04	EEC-10 Export	.000	4.800	
07	Soviet Union	05	O. W. Europe Export	.000	4.400	
07	Soviet Union	06	Australia	.000	4.900	
07	Soviet Union		Global (Total)	15100.000		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
08	People Rep. China	01	Canada	2800.000	6.000	LBC
08	People Rep. China	02	United States	6187.934	.000	OPT
08	People Rep. China	03	Argentina	200.000	15.700	LBC
08	People Rep. China	04	EEC-10 Export	500.000	13.200	LBC
08	People Rep. China	05	O. W. Europe Export	.000	17.800	
08	People Rep. China	06	Australia	2000.000	1.800	LBC
08	People Rep. China		Global (Total)	11687.934		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
09	Japan	01	Canada	1300.000	7.900	LBC
09	Japan	02	United States	3300.000	.000	OPT
09	Japan	03	Argentina	.000	16.400	
09	Japan	04	EEC-10 Export	.000	19.800	
09	Japan	05	O. W. Europe Export	.000	22.600	
09	Japan	06	Australia	900.000	6.600	LBC
09	Japan		Global (Total)	5500.000		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
10	East Asia	01	Canada	.000	2.600	
10	East Asia	02	United States	2811.098	.000	OPT
10	East Asia	03	Argentina	.000	12.700	
10	East Asia	04	EEC-10 Export	.000	11.400	
10	East Asia	05	O. W. Europe Export	.000	16.000	
10	East Asia	06	Australia	3415.912	.000	OPT
10	East Asia		Global (Total)	6227.010		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
11	Southeast Asia	01	Canada	.000	16.800	
11	Southeast Asia	02	United States	.000	22.000	
11	Southeast Asia	03	Argentina	.000	8.200	
11	Southeast Asia	04	EEC-10 Export	.000	18.500	
11	Southeast Asia	05	O. W. Europe Export	.000	23.000	
11	Southeast Asia	06	Australia	779.805	.000	OPT
11	Southeast Asia		Global (Total)	779.805		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
12	South Asia	01	Canada	.000	8.200	
12	South Asia	02	United States	.000	11.200	
12	South Asia	03	Argentina	.000	.700	
12	South Asia	04	EEC-10 Export	.000	15.600	
12	South Asia	05	O. W. Europe Export	.000	16.200	
12	South Asia	06	Australia	3452.971	.000	OPT
12	South Asia		Global (Total)	3452.971		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
13	West Asia	01	Canada	1500.000	.000	OPT
13	West Asia	02	United States	.000	2.700	
13	West Asia	03	Argentina	200.000	11.000	LBC
13	West Asia	04	EEC-10 Export	4900.000	.000	OPT
13	West Asia	05	O. W. Europe Export	.000	1.500	
13	West Asia	06	Australia	400.000	12.600	LBC
13	West Asia		Global (Total)	7000.000		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
14	North Africa	01	Canada	300.000	6.500	LBC
14	North Africa	02	United States	2000.000	5.900	LBC
14	North Africa	03	Argentina	.000	9.700	
14	North Africa	04	EEC-10 Export	6900.000	.000	OPT
14	North Africa	05	O. W. Europe Export	800.000	.000	OPT
14	North Africa	06	Australia	1000.000	13.100	LBC
14	North Africa		Global (Total)	11000.000		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
15	Central Africa	01	Canada	3239.824	.000	OPT
15	Central Africa	02	United States	.000	4.600	
15	Central Africa	03	Argentina	729.577	.000	OPT
15	Central Africa	04	EEC-10 Export	.000	5.800	
15	Central Africa	05	O. W. Europe Export	.000	3.800	
15	Central Africa	06	Australia	.000	2.500	
15	Central Africa		Global (Total)	3969.401		

Please press <return> to continue. <return>

ID	Importer (Sink)	ID	Exporter (Source)	Quantity	Linkage	State
16	South Africa	01	Canada	.000	8.800	
16	South Africa	02	United States	.000	3.700	
16	South Africa	03	Argentina	.000	8.200	
16	South Africa	04	EEC-10 Export	.000	13.800	
16	South Africa	05	O. W. Europe Export	.000	13.400	
16	South Africa	06	Australia	100.000	.000	OPT
16	South Africa		Global (Total)	100.000		

Non-Zero Non-Binding Flows (OPT): 21
Binding Lower Bound Constraints (LBC): 15
Binding Upper Bound Constraints (UBC): 00

Hardcopy Reports

When the RPT command is entered, a list of reports is presented to the user one by one. The reports are written to the output data file, if the user answers

the yes/no question with a Y (or y) or enters <return>. The hardcopy reports are printed after exiting program GTP with the DOS PRINT command or the COPY command. The hardcopy reports for this example problem are included as an appendix to this report.

```
> RPT <return>

Report Description                                    Write It
------------------------------------------------------------------------

Quota Levels, Tariffs, and Exchange Rates             (Y/N)? <return>
Flow Constraints and Transport Costs                  (Y/N)? <return>
Excess Schedule Coefficients                          (Y/N)? <return>
Exporter (Source) Flows and Values                    (Y/N)? <return>
Importer (Sink) Flows and Values                      (Y/N)? <return>
Revenues and Costs                                    (Y/N)? <return>
Price Linkages and Flow Status                        (Y/N)? <return>
Internal Prices and Tariff Equivalents                (Y/N)? <return>
Solution Status and Author                            (Y/N)? <return>
```

Exiting

Program execution is terminated with END command. The program asks some questions about your input data file (two input data files if you have read an input data file into the program and made modifications), and the output data file if the RPT command was used. Then the program returns to the operating system.

```
> END <return>

Current IDF: WWM80S.IDF     Write To Disk (Y/N)? <return>
Writing Input Data File...

Current ODF: WWM80S.ODF     Save Disk File (Y/N)? <return>

B>
```

Printing Hardcopy Reports

In the example, the reports available with the RPT command were written to a file (WWM80S.ODF) on the logged drive. Now assume that you want to print these reports. As previously mentioned, the reports are written in a 133-column format, so you will need either a wide carriage printer or to set your 80-column printer to condensed print mode. Once the printer is set up, you need to enter one of the following standard DOS commands to print the file.

```
> PRINT WWM80S.ODF    or    > COPY WWM80S.ODF LPT1
```

After entering the print command, you'll have time to go get a cup of coffee and celebrate your achievement while the file is printing. The hardcopy reports for this example problem are reproduced in the Appendix.

Using an Existing Input Data File

Now suppose that you have an existing input data file and you want to make some modifications and resolve the problem. Consider the spatial equilibrium

problem I used for an example. What does this example problem imply about the elasticity of excess demand for wheat faced by the United States? In the example, the United States exported almost 43 million metric tons of wheat at a price of about $175 per ton. We can fix United States exports at 42 and 44 million metric tons, solve the two spatial equilibrium problems, and then calculate an implied arc elasticity from the two price-quantity solutions. From the data reproduced below, I calculated an elasticity estimate of -0.7.

```
B> GTP

**********************************************************************

     Solution of the Generalized Transportation
     Problem Using the Vector Sandwich Method
     Fixed-Point Algorithm of Kuhn and MacKinnon.

     Address Questions and Comments To:

     Forrest D. Holland, USDA-ERS-IED
     Department of Agricultural Economics
     Purdue University
     West Lafayette, Indiana 47907

     Phone: (317)-494-4311
            (FTS)-284-4311

     Coded on an IBM-XT using Microsoft Fortran
     Version 1.0 - October 1984

**********************************************************************

Initial Input Data File Name (IDF)? WWM80S.IDF <return>
Disk File Exists.  Read It Into Memory (Y/N)? <return>
Reading Input Data File....

Initial Output Data File Name (ODF)? <return>
Using Default Output Data File Name:  SCRATCH.ODF?

> SET QSX 2 <return>
ID   Region Name          Coef.          Old Value        New Value
-------------------------------------------------------------------
02   United States        QSX A             .000          42000 <return>
                          QSX B          875.000              0 <return>
                          QSX C             .750              1 <return>

> RUN <return>

Scanning For Data Errors...

Starting VSM Algorithm
Subdivision:  1  RPC = .48048989  RQC = .22378725  CX =  14  CM =  14  AL =   5
Subdivision:  2  RPC = .23395148  RQC = .23115648  CX =  71  CM =  71  AL =  38
Subdivision:  3  RPC = .02936940  RQC = .02225844  CX =  91  CM =  91  AL =  51
Subdivision:  4  RPC = .01053608  RQC = .00529084  CX = 126  CM = 126  AL =  82
```

```
Subdivision:  5  RPC = .00248317  RQC = .00081820  CX = 162  CM = 162  AL = 104
Subdivision:  6  RPC = .00053555  RQC = .00022697  CX = 189  CM = 189  AL = 142
Subdivision:  7  RPC = .00022702  RQC = .00011206  CX = 229  CM = 229  AL = 163
Subdivision:  8  RPC = .00003875  RQC = .00002801  CX = 263  CM = 263  AL = 201
Subdivision:  9  RPC = .00002838  RQC = .00000839  CX = 322  CM = 322  AL = 256
Subdivision: 10  RPC = .00000330  RQC = .00000155  CX = 365  CM = 365  AL = 289
Subdivision: 11  RPC = .00000101  RQC = .00000017  CX = 402  CM = 402  AL = 315
Subdivision: 12 RPC = .00000028  RQC = .00000014  CX = 451  CM = 451  AL = 367
Subdivision: 13  RPC = .00000004  RQC = .00000001  CX = 470  CM = 470  AL = 384
Exit VSM:        RPC = .00000004  RQC = .00000001  CX = 471  CM = 471  AL = 384
Requested Convergence Could Not Be Attained?

> SEE PTX <return>
```

ID	Exporter (Source)	Prices: Trade	Prices: Border	Prices: Domestic	Quota Tariffs: Specific	Quota Tariffs: A-Valorem
01	Canada	186.448	186.448	186.448	.000	.000
02	United States	182.248	182.248	182.248	.000	.000
03	Argentina	189.148	189.148	189.148	.000	.000
04	EEC-10 Export	191.848	191.848	191.848	.000	.000
05	O. W. Europe Export	191.448	191.448	191.448	.000	.000
06	Australia	187.248	187.248	187.248	.000	.000
	Weighted Average	185.482	185.482	185.482	.000	.000

```
> SEE QTX <return>
```

ID	Exporter (Source)	Quantity: Traded	Quantity: Value	Tariffs: Specific	Tariffs: A-Valorem	Revenue or Cost
01	Canada	16726.883	3118694.7	.0	.0	3118694.7
02	United States	42000.000	7654418.2	.0	.0	7654418.2
03	Argentina	4138.532	782795.2	.0	.0	782795.2
04	EEC-10 Export	12300.000	2359731.0	.0	.0	2359731.0
05	O. W. Europe Export	800.000	153158.4	.0	.0	153158.4
06	Australia	12114.783	2268469.5	.0	.0	2268469.5
	Global (Total)	88080.197	16337267.0	.0	.0	16337267.0

```
> SET QSX 2 <return>
```

ID	Region Name	Coef.	Old Value	New Value
02	United States	QSX A	42000.000	44000 <return>
		QSX B	.000	<return>
		QSX C	1.000	<return>

```
> RUN <return>

Scanning For Data Errors...

Starting VSM Algorithm
Subdivision:  1  RPC = .76683464  RQC = .31724366  CX =  16  CM =  16  AL =  12
Subdivision:  2  RPC = .30358634  RQC = .31690192  CX =  54  CM =  54  AL =  34
Subdivision:  3  RPC = .03474297  RQC = .02412610  CX =  82  CM =  82  AL =  41
Subdivision:  4  RPC = .00872896  RQC = .00636196  CX = 112  CM = 112  AL =  65
```

```
Subdivision:  5  RPC = .00292490  RQC = .00069577  CX = 145  CM = 145  AL =  85
Subdivision:  6  RPC = .00080892  RQC = .00015197  CX = 185  CM = 185  AL = 116
Subdivision:  7  RPC = .0005360   RQC = .00004430  CX = 226  CM = 226  AL = 155
Subdivision:  8  RPC = .00004976  RQC = .00000931  CX = 260  CM = 260  AL = 174
Subdivision:  9  RPC = .00001462  RQC = .00000664  CX = 324  CM = 324  AL = 221
Subdivision: 10  RPC = .00000447  RQC = .00000091  CX = 378  CM = 378  AL = 250
Subdivision:11  RPC = .00000070  RQC = .00000021  CX = 420  CM = 420  AL = 279
Subdivision: 12  RPC = .00000013  RQC = .00000010  CX = 453  CM = 453  AL = 307
Subdivision: 13  RPC = .00000005  RQC = .00000002  CX = 481  CM = 481  AL = 339
Subdivision: 14  RPC = .00000001  RQC = .00000000  CX = 508  CM = 508  AL = 362
Exit VSM:        RPC = .00000001  RQC = .00000000  CX = 509  CM = 509  AL = 362
Requested Convergence Could Not Be Attained

> SEE PTX <return>
```

ID	Exporter (Source)	Prices: Trade	Prices: Border	Prices: Domestic	Quota Tariffs: Specific	Quota Tariffs: A-Valorem
01	Canada	174.739	174.739	174.739	.000	.000
02	United States	170.539	170.539	170.539	.000	.000
03	Argentina	177.439	177.439	177.439	.000	.000
04	EEC-10 Export	180.139	180.139	180.139	.000	.000
05	O. W. Europe Export	179.739	179.739	179.739	.000	.000
06	Australia	175.539	175.539	175.539	.000	.000
	Weighted Average	173.690	173.690	173.690	.000	.000

```
> SEE QTX <return>
```

ID	Exporter (Source)	Quantity: Traded	Quantity: Value	Tariffs: Specific	Tariffs: A-Valorem	Revenue or Cost
01	Canada	16193.145	2829576.7	.0	.0	2829576.7
02	United States	44000.000	7503723.3	.0	.0	7503723.3
03	Argentina	4112.170	729660.0	.0	.0	729660.0
04	EEC-10 Export	12300.000	2215711.7	.0	.0	2215711.7
05	O. W. Europe Export	800.000	143791.3	.0	.0	143791.3
06	Australia	11920.784	2092564.4	.0	.0	2092564.4
	Global (Total)	89326.099	15515027.5	.0	.0	15515027.5

```
> END <return>

Current IDF: WWM80S.IDF     Save Original Disk File (Y/N)?  <return>
Write Modified Input Data File To Disk (Y/N)?  N <return>
Verify! Ignore Modified Input Data File (N/Y)?  Y <return>


B>
```

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[2] Holland, Forrest D. and Jerry A. Sharples. "World Wheat Trade: Implications for U.S. Exports," Department of Agricultural Economics, Purdue University, Staff Paper No. 84-20, November 1984.

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[4] MacKinnon, James G. "An Algorithm for the Generalized Transportation Problem," Regional Science and Urban Economics, 5(1975):445-464.

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[9] Zangwill, W.I. and C.B. Garcia. Pathways to Solutions, Fixed Points, and Equilibria. Englewood Cliffs, New Jersey: Prentice-Hall, 1981.

Quota Levels, Tariffs, and Exchange Rates: Holland-Sharples 1980 Base Short-Run Wheat Model

ID	Exporter (Source)	Export Quantity Lower Bound	Export Quantity Upper Bound	Export Tariff Specific	Export Tariff Ad Valorem	Exchange Rate
01	Canada	.000	500000.000	.000	.000	1.000
02	United States	.000	500000.000	.000	.000	1.000
03	Argentina	.000	500000.000	.000	.000	1.000
04	EEC-10 Export	.000	500000.000	.000	.000	1.000
05	O. W. Europe Export	.000	500000.000	.000	.000	1.000
06	Australia	.000	500000.000	.000	.000	1.000

ID	Importer (Sink)	Import Quantity Lower Bound	Import Quantity Upper Bound	Import Tariff Specific	Import Tariff Ad Valorem	Exchange Rate
01	Central America	.000	500000.000	.000	.000	1.000
02	Brazil	.000	500000.000	.000	.000	1.000
03	Other S. America	.000	500000.000	.000	.000	1.000
04	EEC-10 Import	.000	500000.000	.000	.000	1.000
05	O. W. Europe Import	.000	500000.000	.000	.000	1.000
06	Eastern Europe	.000	500000.000	.000	.000	1.000
07	Soviet Union	.000	500000.000	.000	.000	1.000
08	Peoples Rep. China	.000	500000.000	.000	.000	1.000
09	Japan	.000	500000.000	.000	.000	1.000
10	East Asia	.000	500000.000	.000	.000	1.000
11	Southeast Asia	.000	500000.000	.000	.000	1.000
12	South Asia	.000	500000.000	.000	.000	1.000
13	West Asia	.000	500000.000	.000	.000	1.000
14	North Africa	.000	500000.000	.000	.000	1.000
15	Central Africa	.000	500000.000	.000	.000	1.000
16	South Africa	.000	500000.000	.000	.000	1.000

Flow Constraints and Transport Costs: Holland-Sharples 1980 Base Short-Run Wheat Model

ID	Exporter (Source)	ID	Importer (Sink)	Export Quantity Lower Bound	Export Quantity Upper Bound	Transport Cost
01	Canada	01	Central America	300.000	500000.000	19.300
		02	Brazil	500.000	500000.000	21.000
		03	Other S. America	.000	500000.000	23.000

		04	EEC-10 Import	.000	500000.000	13.200
		05	O. W. Europe Import	.000	500000.000	15.400
		06	Eastern Europe	500.000	500000.000	16.000
		07	Soviet Union	3200.000	500000.000	16.300
		08	Peoples Rep. China	2800.000	500000.000	28.200
		09	Japan	1300.000	500000.000	20.300
		10	East Asia	.000	500000.000	26.600
		11	Southeast Asia	.000	500000.000	38.800
		12	South Asia	.000	500000.000	37.000
		13	West Asia	150.000	500000.000	23.500
		14	North Africa	300.000	500000.000	26.500
		15	Central Africa	.000	500000.000	31.200
		16	South Africa	.000	500000.000	35.400
	02 United States	01	Central America	600.000	500000.000	13.800
		02	Brazil	.000	500000.000	15.000
		03	Other S. America	.000	500000.000	16.500
		04	EEC-10 Import	.000	500000.000	12.000
		05	O. W. Europe Import	75.000	500000.000	15.600
		06	Eastern Europe	750.000	500000.000	20.200
		07	Soviet Union	3000.000	500000.000	19.800
		08	Peoples Rep. China	5100.000	500000.000	26.400
		09	Japan	.000	500000.000	16.600
		10	East Asia	575.000	500000.000	28.200
		11	Southeast Asia	.000	500000.000	48.200
		12	South Asia	.000	500000.000	44.200
		13	West Asia	.000	500000.000	30.400
		14	North Africa	2000.000	500000.000	30.100
		15	Central Africa	.000	500000.000	40.000
		16	South Africa	.000	500000.000	34.500
	03 Argentina	01	Central America	.000	500000.000	25.100
		02	Brazil	.000	500000.000	15.000
		03	Other S. America	.000	500000.000	20.500
		04	EEC-10 Import	.000	500000.000	25.300
		05	O. W. Europe Import	.000	500000.000	25.000
		06	Eastern Europe	.000	500000.000	25.600
		07	Soviet Union	3000.000	500000.000	25.100
		08	Peoples Rep. China	200.000	500000.000	35.200
		09	Japan	.000	500000.000	26.100
		10	East Asia	.000	500000.000	34.000
		11	Southeast Asia	.000	500000.000	27.500
		12	South Asia	.000	500000.000	26.800
		13	West Asia	200.000	500000.000	31.800
		14	North Africa	.000	500000.000	27.000
		15	Central Africa	.000	500000.000	28.500
		16	South Africa	.000	500000.000	32.100
	04 EEC-10 Export	01	Central America	.000	500000.000	20.000
		02	Brazil	.000	500000.000	20.000
		03	Other S. America	.000	500000.000	21.700
		04	EEC-10 Import	.000	500000.000	100.000

		05	O. W. Europe Import	.000	500000.000	12.000
		06	Eastern Europe	.000	500000.000	12.300
		07	Soviet Union	.000	500000.000	15.000
		08	Peoples Rep. China	500.000	500000.000	30.000
		09	Japan	.000	500000.000	26.800
		10	East Asia	.000	500000.000	30.000
		11	Southeast Asia	.000	500000.000	35.100
		12	South Asia	.000	500000.000	39.000
		13	West Asia	.000	500000.000	18.100
		14	North Africa	800.000	500000.000	14.600
		15	Central Africa	.000	500000.000	31.600
		16	South Africa	.000	500000.000	35.000
05	O. W. Europe Export	01	Central America	.000	500000.000	25.000
		02	Brazil	.000	500000.000	25.000
		03	Other S. America	.000	500000.000	25.000
		04	EEC-10 Import	.000	500000.000	12.000
		05	O. W. Europe Import	.000	500000.000	100.000
		06	Eastern Europe	.000	500000.000	12.500
		07	Soviet Union	.000	500000.000	15.000
		08	Peoples Rep. China	.000	500000.000	35.000
		09	Japan	.000	500000.000	30.000
		10	East Asia	.000	500000.000	35.000
		11	Southeast Asia	.000	500000.000	40.000
		12	South Asia	.000	500000.000	40.000
		13	West Asia	.000	500000.000	20.000
		14	North Africa	.000	500000.000	15.000
		15	Central Africa	.000	500000.000	30.000
		16	South Africa	.000	500000.000	35.000
06	Australia	01	Central America	.000	500000.000	27.500
		02	Brazil	.000	500000.000	27.500
		03	Other S. America	.000	500000.000	25.800
		04	EEC-10 Import	.000	500000.000	33.200
		05	O. W. Europe Import	.000	500000.000	39.600
		06	Eastern Europe	.000	500000.000	28.000
		07	Soviet Union	.000	500000.000	19.700
		08	Peoples Rep. China	2000.000	500000.000	23.200
		09	Japan	900.000	500000.000	18.200
		10	East Asia	600.000	500000.000	23.200
		11	Southeast Asia	.000	500000.000	21.200
		12	South Asia	.000	500000.000	28.000
		13	West Asia	400.000	500000.000	35.300
		14	North Africa	1000.000	500000.000	32.300
		15	Central Africa	.000	500000.000	32.900
		16	South Africa	.000	500000.000	25.800

Excess Supply and Demand Schedules: Holland-Sharples 1980 Base Short-Run Wheat Model

ID	Exporter (Source)	Excess Supply Alpha	Excess Supply Beta	Excess Supply Gamma
01	Canada	.000	1225.000	.500
02	United States	.000	875.000	.750
03	Argentina	.000	2450.000	.100
04	EEC-10 Export	12300.000	.000	1.000
05	O. W. Europe Export	800.000	.000	1.000
06	Australia	.000	3275.000	.250

ID	Importer (Sink)	Excess Demand Alpha	Excess Demand Beta	Excess Demand Gamma
01	Central America	.000	10000.000	-.200
02	Brazil	.000	12500.000	-.200
03	Other S. America	.000	31500.000	-.400
04	EEC-10 Import	4500.000	.000	1.000
05	O. W. Europe Import	2200.000	.000	1.000
06	Eastern Europe	5300.000	.000	1.000
07	Soviet Union	15100.000	.000	1.000
08	Peoples Rep. China	.000	825000.000	-.800
09	Japan	5500.000	.000	1.000
10	East Asia	.000	52500.000	-.400
11	Southeast Asia	.000	55000.000	-.800
12	South Asia	.000	250000.000	-.800
13	West Asia	7000.000	.000	1.000
14	North Africa	11000.000	.000	1.000
15	Central Africa	.000	290000.000	-.800
16	South Africa	100.000	.000	1000

Note: Quantity = Alpha + Beta * (Price) ^{Gamma}

Exporter (Source) Flows and Values - Base Currency: Holland-Sharples 1980 Base Short-Run Wheat Model

ID	Exporter (Source)	ID	Importer (Sink)	Export (Source) Quantity	Export (Source) Value	Export (Source) Price	Export Tariff Specific	Export Tariff Ad Valorem	Trans. Cost
01	Canada	01	Central America	300.000	54718.533	182.395	.000	.000	5790.000
		02	Brazil	500.000	91197.554	182.395	.000	.000	10500.000
		06	Eastern Europe	3404.259	620920.119	182.395	.000	.000	54468.138
		07	Soviet Union	3200.000	583664.347	182.395	.000	.000	52160.000
		08	Peoples Rep. China	2800.000	510706.303	182.395	.000	.000	78960.000

		09	Japan	1300.000	237113.641	182.395	.000	.000	26390.000
		13	West Asia	1500.000	273592.657	182.395	.000	.000	35249.999
		14	North Africa	300.000	54718.533	182.395	.000	.000	7950.000
		15	Central Africa	3239.824	590928.001	182.395	.000	.000	101082.500
			Global (All Sinks)	16544.082	3017559.687	182.395	.000	.000	372550.638
			Weighted Average		182.395	182.395	.000	.000	22.519
02	United States	01	Central America	3194.153	569182.513	178.195	.000	.000	44079.317
		02	Brazil	3862.252	688234.484	178.195	.000	.000	57933.786
		03	Other S. America	3824.446	681497.579	178.195	.000	.000	63103.360
		04	EEC-10 Import	4500.000	801877.992	178.195	.000	.000	54000.000
		05	O. W. Europe Import	2200.000	392029.241	178.195	.000	.000	34320.000
		06	Eastern Europe	1895.741	337811.844	178.195	.000	.000	38293.976
		07	Soviet Union	8900.000	1585936.473	178.195	.000	.000	176220.000
		08	Peoples Rep. China	6187.934	1102659.573	178.195	.000	.000	163361.457
		09	Japan	3300.000	588043.861	178.195	.000	.000	54780.000
		10	East Asia	2811.098	500923.859	178.195	.000	.000	79272.955
		14	North Africa	2000.000	356390.219	178.195	.000	.000	60200.000
			Global (All Sinks)	42675.625	7604587.638	178.195	.000	.000	825564.850
			Weighted Average		178.195	178.195	.000	.000	19.345
03	Argentina	07	Soviet Union	3000.000	555285.324	185.095	.000	.000	75300.000
		08	Peoples Rep. China	200.000	37019.022	185.095	.000	.000	7040.000
		13	West Asia	200.000	37019.022	185.095	.000	.000	6360.000
		15	Central Africa	729.577	135041.153	185.095	.000	.000	20792.947
			Global (All Sinks)	4129.577	764364.520	185.095	.000	.000	109492.947
			Weighted Average		185.095	185.095	.000	.000	26.514
04	EEC-10 Export	08	Peoples Rep. China	500.000	93897.554	187.795	.000	.000	15000.000
		13	West Asia	4900.000	920196.035	187.795	.000	.000	88690.001
		14	North Africa	6900.000	1295786.244	187.795	.000	.000	100740.000
			Global (All Sinks)	12300.000	2309879.832	187.795	.000	.000	204430.000
			Weighted Average		187.795	187.795	.000	.000	16.620
05	O. W. Europe Export	14	North Africa	800.000	149916.091	187.395	.000	.000	12000.000
			Global (All Sinks)	800.000	149916.091	187.395	.000	.000	12000.000
			Weighted Average		187.395	187.395	.000	.000	15.000
06	Australia	08	Peoples Rep. China	2000.000	366390.221	183.195	.000	.000	46400.000
		09	Japan	900.000	164875.600	183.195	.000	.000	16380.000
		10	East Asia	3415.912	625778.381	183.195	.000	.000	79249.159
		11	Southeast Asia	779.805	142856.553	183.195	.000	.000	16531.876
		12	South Asia	3452.971	632567.390	183.195	.000	.000	96683.186
		13	West Asia	400.000	73278.044	183.195	.000	.000	14120.000
		14	North Africa	1000.000	183195.111	183.195	.000	.000	32300.000
		16	South Africa	100.000	18319.511	183.195	.000	.000	2580.000
			Global (All Sinks)	12048.688	2207260.810	183.195	.000	.000	304244.221
			Weighted Average		183.195	183.195	.000	.000	25.251
	Global (All Sources)		Global (All Sinks)	88497.973	16053568.578	181.400	.000	.000	1828282.656
			Weighted Average		181.400	181.400	.000	.000	20.659

Importer (Sink) Flows and Values - Base Currency: Holland-Sharples 1980 Base Short-Run Wheat Model

ID	Importer (Sink)	ID	Exporter (Source)	Import (Sink) Quantity	Import (Sink) Value	Import (Sink) Price	Import Tariff Specific	Import Tariff Ad Valorem	Trans. Cost
01	Central America	01	Canada	300.000	60508.533	201.695	.000	.000	5790.000
		02	United States	3194.153	613261.830	191.995	.000	.000	44079.317
			Global (All Sources)	3494.153	673770.363	192.828	.000	.000	49869.317
			Weighted Average		192.828	192.828	.000	.000	14.272
02	Brazil	01	Canada	500.000	101697.554	203.395	.000	.000	10500.000
		02	United States	3862.252	746168.269	193.195	.000	.000	57933.786
			Global (All Sources)	4362.252	847865.823	194.364	.000	.000	68433.786
			Weighted Average		194.364	194.364	.000	.000	15.688
03	Other S. America	02	United States	3824.446	744600.938	194.695	.000	.000	63103.360
			Global (All Sources)	3824.446	744600.938	194.695	.000	.000	63103.360
			Weighted Average		194.695	194.695	.000	.000	16.500
04	EEC-10 Import	02	United States	4500.000	855877.992	190.195	.000	.000	54000.000
			Global (All Sources)	4500.000	855877.992	190.195	.000	.000	54000.000
			Weighted Average		190.195	190.195	.000	.000	12.000
05	O. W. Europe Import	02	United States	2200.000	426349.241	193.795	.000	.000	34320.000
			Global (All Sources)	2200.000	426349.241	193.795	.000	.000	34320.000
			Weighted Average		193.795	193.795	.000	.000	15.600
06	Eastern Europe	01	Canada	3404.259	675388.256	198.395	.000	.000	54468.138
		02	United States	1895.741	376105.820	198.395	.000	.000	38293.976
			Global (All Sources)	5300.000	1051494.076	198.395	.000	.000	92762.114
			Weighted Average		198.395	198.395	.000	.000	17.502
07	Soviet Union	01	Canada	3200.000	635824.347	198.695	.000	.000	52160.000
		02	United States	8900.000	1762156.473	197.995	.000	.000	176220.000
		03	Argentina	3000.000	630585.324	210.195	.000	.000	75300.000
			Global (All Sources)	15100.000	3028566.144	200.567	.000	.000	303680.000
			Weighted Average		200.567	200.567	.000	.000	20.111
08	Peoples Rep. China	01	Canada	2800.000	589666.303	210.595	.000	.000	78960.000
		02	United States	6187.934	1266021.031	204.595	.000	.000	163361.457
		03	Argentina	200.000	44059.022	220.295	.000	.000	7040.000
		04	EEC-10 Export	500.000	108897.554	217.795	.000	.000	15000.000
		06	Australia	2000.000	412790.221	206.395	.000	.000	46400.000
			Global (All Sources)	11687.934	2421434.131	207.174	.000	.000	310761.457
			Weighted Average		207.174	207.174	.000	.000	26.588

09	Japan	01	Canada	1300.000	263503.641	202.695	.000	.000	26390.000
		02	United States	3300.000	642823.861	194.795	.000	.000	54780.000
		06	Australia	900.000	181255.600	201.395	.000	.000	16380.000
			Global (All Sources)	5500.000	1087583.101	197.742	.000	.000	97550.000
			Weighted Average		197.742	197.742	.000	.000	17.736
10	East Asia	02	United States	2811.098	580196.813	206.395	.000	.000	79272.955
		06	Australia	3415.912	705027.540	206.395	.000	.000	79249.159
			Global (All Sources)	6227.010	1285224.353	206.395	.000	.000	158522.114
			Weighted Average		206.395	206.395	.000	.000	25.457
11	Southeast Asia	06	Australia	779.805	159388.429	204.395	.000	.000	16531.876
			Global (All Sources)	779.805	159388.429	204.395	.000	.000	16531.876
			Weighted Average		204.395	204.395	.000	.000	21.200
12	South Asia	06	Australia	3452.971	729250.576	211.195	.000	.000	96683.186
			Global (All Sources)	3452.971	729250.576	211.195	.000	.000	96683.186
			Weighted Average		211.195	211.195	.000	.000	28.000
13	West Asia	01	Canada	1500.000	308842.657	205.895	.000	.000	35249.999
		03	Argentina	200.000	43379.022	216.895	.000	.000	6360.000
		04	EEC-10 Export	4900.000	1008886.035	205.895	.000	.000	88690.001
		06	Australia	400.000	87398.044	218.495	.000	.000	14120.000
			Global (All Sources)	7000.000	1448505.757	206.929	.000	.000	144420.000
			Weighted Average		206.929	206.929	.000	.000	20.631
14	North Africa	01	Canada	300.000	62668.533	208.895	.000	.000	7950.000
		02	United States	2000.000	416590.219	208.295	.000	.000	60200.000
		04	EEC-10 Export	6900.000	1396526.243	202.395	.000	.000	100740.000
		05	O. W. Europe Export	800.000	161916092	202.395	.000	.000	12000.000
		06	Australia	1000.000	215495.111	215.495	.000	.000	32300.000
			Global (All Sources)	11000.000	2253196.197	204.836	.000	.000	213190.000
			Weighted Average		204.836	204.836	.000	.000	19.381
15	Central Africa	01	Canada	3239.824	692010.501	213.595	.000	.000	101082.500
		03	Argentina	729.577	155834.100	213.595	.000	.000	20792.947
			Global (All Sources)	3969.401	847844.601	213.595	.000	.000	121875.448
			Weighted Average		213.595	213.595	.000	.000	30.704
16	South Africa	06	Australia	100.000	20899.511	208.995	.000	.000	2580.000
			Global (All Sources)	100.000	20899.511	208.995	.000	.000	2580.000
			Weighted Average		208.995	208.995	.000	.000	25.800
	Global (All Sinks)		Global (All Sources)	88497.973	17881851.235	202.059	.000	.000	1828282.656
			Weighted Average		202.059	202.059	.000	.000	20.659

Exporter (Source) Revenue - Base Currency: Holland-Sharples 1980 Base Short-Run Wheat Model

ID	Exporter (Source)	Export Value	Export Tariff --- Specific	Ad Valorem	Tot. Revenue
01	Canada	3017559.686	.000	.000	3017559.686
02	United States	7604587.631	.000	.000	7604587.631
03	Argentina	764364.519	.000	.000	764364.519
04	EEC-10 Export	2309879.828	.000	.000	2309879.828
05	O. W. Europe Export	149916.090	.000	.000	149916.090
06	Australia	2207260.809	.000	.000	2207260.809
	Global (All Sources)	16053568.563	.000	.000	16053568.563

Importer (Sink) Cost - Base Currency: Holland-Sharples 1980 Base Short-Run Wheat Model

ID	Importer (Sink)	Import Value	Import Tariff --- Specific	Ad Valorem	Total Cost
01	Central America	673770.363	.000	.000	673770.363
02	Brazil	847865.823	.000	.000	847865.823
03	Other S. America	744600.938	.000	.000	744600.938
04	EEC-10 Import	855877.992	.000	.000	855877.992
05	O. W. Europe Import	426349.241	.000	.000	426349.241
06	Eastern Europe	1051494.076	.000	.000	1051494.076
07	Soviet Union	3028566.144	.000	.000	3028566.144
08	Peoples Rep. China	2421434.131	.000	.000	2421434.131
09	Japan	1087583.101	.000	.000	1087583.101
10	East Asia	1285224.353	.000	.000	1285224.353
11	Southeast Asia	159388.429	.000	.000	159388.429
12	South Asia	729250.576	.000	.000	729250.576
13	West Asia	1448505.757	.000	.000	1448505.757
14	North Africa	2253196.197	.000	.000	2253196.197
15	Central Africa	847844.601	.000	.000	847844.601
16	South Africa	20899.511	.000	.000	20899.511
	Global (All Sinks)	17881851.235	.000	.000	17881851.235

Price Linkages - Base Currency: Holland-Sharples 1980 Base Short-Run Wheat Model

ID	Exporter (Source)	ID	Importer (Sink)	Border Price	Export Tariff	Export Price	Cost Trans.	Landed Price	Diff. Price	Import Price	Import Tariff	Border Price	Flow Status
01	Canada	01	Central America	182.395	.000	182.395	19.300	201.695	9.700	191.995	.000	191.995	LBC
		02	Brazil	182.395	.000	182.395	21.000	203.395	10.200	193.195	.000	193.195	LBC
		03	Other S. America	182.395	.000	182.395	23.000	205.395	10.700	194.695	.000	194.695	
		04	EEC-10 Import	182.395	.000	182.395	13.200	195.595	5.400	190.195	.000	190.195	
		05	O. W. Europe Import	182.395	.000	182.395	15.400	197.795	4.000	193.795	.000	193.795	
		06	Eastern Europe	182.395	.000	182.395	16.000	198.395	.000	198.395	.000	198.395	OPT
		07	Soviet Union	182.395	.000	182.395	16.300	198.695	.700	197.995	.000	197.995	LBC
		08	Peoples Rep. China	182.395	.000	182.395	28.200	210.595	6.000	204.595	.000	204.595	LBC
		09	Japan	182.395	.000	182.395	20.300	202.695	7.900	194.795	.000	194.795	LBC
		10	East Asia	182.395	.000	182.395	26.600	208.995	2.600	206.395	.000	206.395	

		11	Southeast Asia	182.395	.000	182.395	38.800	221.195	16.800	204.395	.000	204.395	
		12	South Asia	182.395	.000	182.395	37.000	219.395	8.200	211.195	.000	211.195	
		13	West Asia	182.395	.000	182.395	23.500	205.895	.000	205.895	.000	205.895	OPT
		14	North Africa	182.395	.000	182.395	26.500	208.895	6.500	202.395	.000	202.395	LBC
		15	Central Africa	182.395	.000	182.395	31.200	213.595	.000	213.595	.000	213.595	OPT
		16	South Africa	182.395	.000	182.395	35.400	217.795	8.800	208.995	.000	208.995	
02	United States	01	Central America	178.195	.000	178.195	13.800	191.995	.000	191.995	.000	191.995	OPT
		02	Brazil	178.195	.000	178.195	15.000	193.195	.000	193.195	.000	193.195	OPT
		03	Other S. America	178.195	.000	178.195	16.500	194.695	.000	194.695	.000	194.695	OPT
		04	EEC-10 Import	78.195	.000	178.195	12.000	190.195	.000	190.195	.000	190.195	OPT
		05	O. W. Europe Import	178.195	.000	178.195	15.600	193.795	.000	193.795	.000	193.795	OPT
		06	Eastern Europe	178.195	.000	178.195	20.200	198.395	.000	198.395	.000	198.395	OPT
		07	Soviet Union	178.195	.000	178.195	19.800	197.995	.000	197.995	.000	197.995	OPT
		08	Peoples Rep. China	178.195	.000	178.195	26.400	204.595	.000	204.595	.000	204.595	OPT
		09	Japan	178.195	.000	178.195	16.600	194.795	.000	194.795	.000	194.795	OPT
		10	East Asia	178.195	.000	178.195	28.200	206.395	.000	206.395	.000	206.395	OPT
		11	Southeast Asia	178.195	.000	178.195	48.200	226.395	22.000	204.395	.000	204.395	
		12	South Asia	178.195	.000	178.195	44.200	222.395	11.200	211.195	.000	211.195	
		13	West Asia	178.195	.000	178.195	30.400	208.595	2.700	205.895	.000	205.895	
		14	North Africa	178.195	.000	178.195	30.100	208.295	5.900	202.395	.000	202.395	LBC
		15	Central Africa	178.195	.000	178.195	40.000	218.195	4.600	213.595	.000	213.595	
		16	South Africa	178.195	.000	178.195	34.500	212.695	3.700	208.995	.000	208.995	
03	Argentina	01	Central America	185.095	.000	185.095	25.100	210.195	18.200	191.995	.000	191.995	
		02	Brazil	185.095	.000	185.095	15.000	200.095	6.900	193.195	.000	193.195	
		03	Other S. America	185.095	.000	185.095	20.500	205.595	10.900	194.695	.000	194.695	
		04	EEC-10 Import	185.095	.000	185.095	25.300	210.395	20.200	190.195	.000	190.195	
		05	O. W. Europe Import	185.095	.000	185.095	25.000	210.095	16.300	193.795	.000	193.795	
		06	Eastern Europe	185.095	.000	185.095	25.600	210.695	12.300	198.395	.000	198.395	
		07	Soviet Union	185.095	.000	185.095	25.100	210.195	12.200	197.995	.000	197.995	LBC
		08	Peoples Rep. China	185.095	.000	185.095	35.200	220.295	15.700	204.595	.000	204.595	LBC
		09	Japan	185.095	.000	185.095	26.100	211.195	16.400	194.795	.000	194.795	
		10	East Asia	185.095	.000	185.095	34.000	219.095	12.700	206.395	.000	206.395	
		11	Southeast Asia	185.095	.000	185.095	27.500	212.595	8.200	204.395	.000	204.395	
		12	South Asia	185.095	.000	185.095	26.800	211.895	.700	211.195	.000	211.195	
		13	West Asia	185.095	.000	185.095	31.800	216.895	11.000	205.895	.000	205.895	LBC
		14	North Africa	185.095	.000	185.095	27.000	212.095	9.700	202.395	.000	202.395	
		15	Central Africa	185.095	.000	185.095	28.500	213.595	.000	213.595	.000	213.595	OPT
		16	South Africa	185.095	.000	185.095	32.100	217.195	8.200	208.995	.000	208.995	
04	EEC-10 Export	01	Central America	187.795	.000	187.795	20.000	207.795	15.800	191.995	.000	191.995	
		02	Brazil	187.795	.000	187.795	20.000	207.795	14.600	193.195	.000	193.195	
		03	Other S. America	187.795	.000	187.795	21.700	209.495	14.800	194.695	.000	194.695	
		04	EEC-10 Import	187.795	.000	187.795	100.000	287.795	97.600	190.195	.000	190.195	
		05	O. W. Europe Import	187.795	.000	187.795	12.000	199.795	6.000	193.795	.000	193.795	
		06	Eastern Europe	187.795	.000	187.795	12.300	200.095	1.700	198.395	.000	198.395	
		07	Soviet Union	187.795	.000	187.795	15.000	202.795	4.800	197.995	.000	197.995	
		08	Peoples Rep. China	187.795	.000	187.795	30.000	217.795	13.200	204.595	.000	204.595	LBC
		09	Japan	187.795	.000	187.795	26.800	214.595	19.800	194.795	.000	194.795	
		10	East Asia	187.795	.000	187.795	30.000	217.795	11.400	206.395	.000	206.395	
		11	Southeast Asia	187.795	.000	187.795	35.100	222.895	18.500	204.395	.000	204.395	

		12	South Asia	187.795	.000	187.795	39.000	226.795	15.600	211.195	.000	211.195	
		13	West Asia	187.795	.000	187.795	18.100	205.895	.000	205.895	.000	205.895	OPT
		14	North Africa	187.795	.000	187.795	14.600	202.395	.000	202.395	.000	202.395	OPT
		15	Central Africa	187.795	.000	187.795	31.600	219.395	5.800	213.595	.000	213.595	
		16	South Africa	187.795	.000	187.795	35.000	222.795	13.800	208.995	.000	208.995	
05	O. W. Europe Export	01	Central America	187.395	.000	187.395	25.000	212.395	20.400	191.995	.000	191.995	
		02	Brazil	187.395	.000	187.395	25.000	212.395	19.200	193.195	.000	193.195	
		03	Other S. America	187.395	.000	187.395	25.000	212.395	17.700	194.695	.000	194.695	
		04	EEC-10 Import	187.395	.000	187.395	12.000	199.395	9.200	190.195	.000	190.195	
		05	O. W. Europe Import	187.395	.000	187.395	100.000	287.395	93.600	193.795	.000	193.795	
		06	Eastern Europe	187.395	.000	187.395	12.500	199.895	1.500	198.395	.000	198.395	
		07	Soviet Union	187.395	.000	187.395	15.000	202.395	4.400	197.995	.000	197.995	
		08	Peoples Rep. China	187.395	.000	187.395	35.000	222.395	17.800	204.595	.000	204.595	
		09	Japan	187.395	.000	187.395	30.000	217.395	22.600	194.795	.000	194.795	
		10	East Asia	187.395	.000	187.395	35.000	222.395	16.000	206.395	.000	206.395	
		11	Southeast Asia	187.395	.000	187.395	40.000	227.395	23.000	204.395	.000	204.395	
		12	South Asia	187.395	.000	187.395	40.000	227.395	16.200	211.195	.000	211.195	
		13	West Asia	187.395	.000	187.395	20.000	207.395	1.500	205.895	.000	205.895	
		14	North Africa	187.395	.000	187.395	15.000	202.395	.000	202.395	.000	202.395	OPT
		15	Central Africa	187.395	.000	187.395	30.000	217.395	3.800	213.595	.000	213.595	
		16	South Africa	187.395	.000	187.395	35.000	222.395	13.400	208.995	.000	208.995	
06	Australia	01	Central America	183.195	.000	183.195	27.500	210.695	18.700	191.995	.000	191.995	
		02	Brazil	183.195	.000	183.195	27.500	210.695	17.500	193.195	.000	193.195	
		03	Other S. America	183.195	.000	183.195	25.800	208.995	14.300	194.695	.000	194.695	
		04	EEC-10 Import	183.195	.000	183.195	33.200	216.395	26.200	190.195	.000	190.195	
		05	O. W. Europe Import	183.195	.000	183.195	39.600	222.795	29.000	193.795	.000	193.795	
		06	Eastern Europe	183.195	.000	183.195	28.000	211.195	12.800	198.395	.000	198.395	
		07	Soviet Union	183.195	.000	183.195	19.700	202.895	4.900	197.995	.000	197.995	
		08	Peoples Rep. China	183.195	.000	183.195	23.200	206.395	1.800	204.595	.000	204.595	LBC
		09	Japan	183.195	.000	183.195	18.200	201.395	6.600	194.795	.000	194.795	LBC
		10	East Asia	183.195	.000	183.195	23.200	206.395	.000	206.395	.000	206.395	OPT
		11	Southeast Asia	183.195	.000	183.195	21.200	204.395	.000	204.395	.000	204.395	OPT
		12	South Asia	183.195	.000	183.195	28.000	211.195	.000	211.195	.000	211.195	OPT
		13	West Asia	183.195	.000	183.195	35.300	218.495	12.600	205.895	.000	205.895	LBC
		14	North Africa	183.195	.000	183.195	32.300	215.495	13.100	202.395	.000	202.395	LBC
		15	Central Africa	183.195	.000	183.195	32.900	216.095	2.500	213.595	.000	213.595	
		16	South Africa	183.195	.000	183.195	25.800	208.995	.000	208.995	.000	208.995	OPT

Non-Zero Non-Binding Flows (OPT): 21
Binding Lower Bound Constraints (LBC): 15
Binding Upper Bound Constraints (UBC): 0

****
Requested Convergence Could Not Be Attained RPC= .000000022 RQC= .000000008
****

Solution of the Generalized Transportation
Problem Using the Vector Sandwich Method
Fixed-Point Algorithm of Kuhn and MacKinnon.

Address Questions and Comments To:

Forrest D. Holland, USDA-ERS-IED
Department of Agricultural Economics
Purdue University
West Lafayette, Indiana 47907

Phone: (317)-494-4311
(FTS)-284-4311

Coded on an IBM-XT using Microsoft Fortran

Version 1.0 - October 1984

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*Holland-Sharples 1980 Base Short-Run Wheat Model *
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